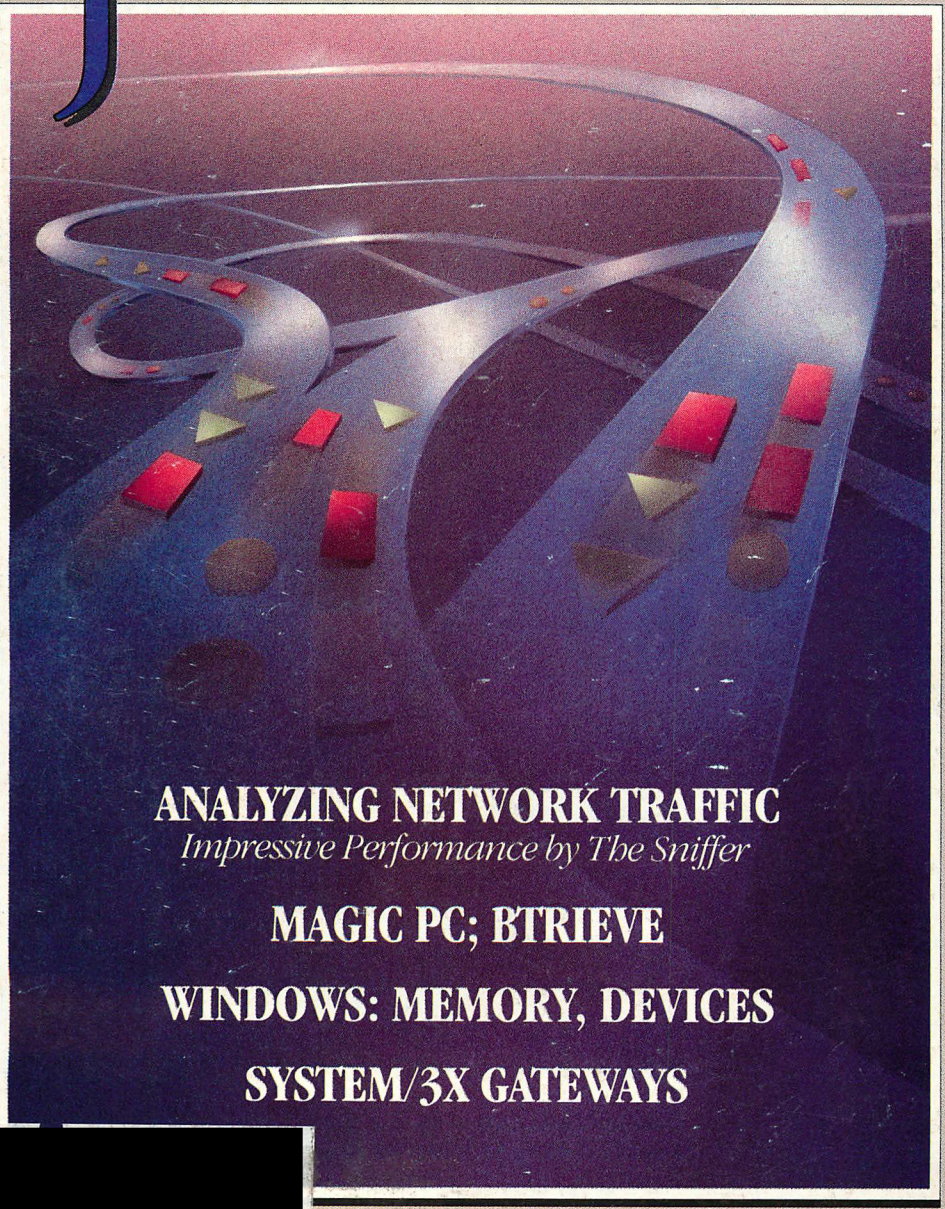
OCTOBER 1987 VOL. 5 NO. 10 $3.95

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ANALYZING NETWORK TRAFFIC

Impressive Performance by The Sniffer

MAGIC PC; BTRIEVE

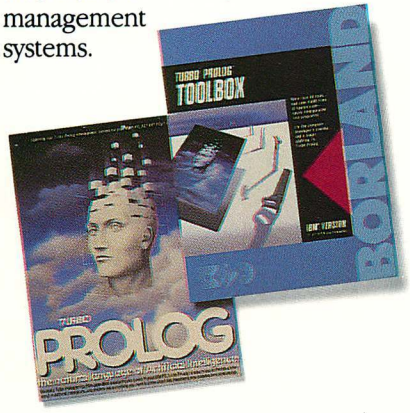
WINDOWS: MEMORY, DEVICES

SYSTEM/3X GATEWAYS

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Turbo Prolog: The Natural Language of Artificial Intelligence

Whether you're a first-time programmer or an experienced one, Turbo Prolog's natural implementation of Artificial Intelligence soon shows you how to build expert systems, natural language interfaces, customized knowledge bases and smart information management systems.



Turbo Prolog and Turbo C work hand-in-hand

Turbo Prolog® interfaces perfectly with Turbo C® because they're both designed to work with each other.

The Turbo Prolog/Turbo C combination means that you can now build powerful commercial applications using two of the most powerful languages available.

Turbo Prolog's development system includes:

- ☑ A complete Prolog compiler that is a variation of the Clocksin and Mellish Edinburgh standard Prolog.
- ☑ A full-screen interactive editor.
- ☑ Support for both graphic and text windows.
- ☑ All the tools that let you build your own expert systems and **AI** applications with unprecedented ease.

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BI-1131A

> "An affordable, fast, and easy-to-use language that will delight the newcomer . . . You experienced Prolog hackers will likewise be delighted, if not astonished, by the features and performance of the Turbo Prolog development environment.
>
> Turbo Prolog offers generally the fastest and most approachable implementation of that language."
>
> *Darryl Rubin, AI Expert*

How Turbo Prolog's new Toolbox adds 80 powerful tools and 8000 lines of source code

In keeping with Borland tradition, we've quickly added the new Turbo Prolog Toolbox™ to Turbo Prolog.

With 80 tools and 8000 lines of source code that can easily be incorporated into your own programs—and 40 sample programs that show you how to put these AI tools to work—the Turbo Prolog Toolbox is a highly intelligent, high-performance addition.
Only $99.95!

Turbo Prolog Toolbox features include:

- ☑ Business graphics generation: boxes, circles, ellipses, bar charts, pie charts, scaled graphics
- ☑ Complete communications package: supports XMODEM protocol
- ☑ File transfers from Reflex,® dBASE III,® 1-2-3,® Symphony®
- ☑ A unique parser generator: construct your own compiler or query language
- ☑ Sophisticated user-interface design tools
- ☑ Contains 40 example programs
- ☑ Easy-to-use screen editor: design your screen layout and I/O
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- ☑ Over 8,000 lines of source code you can incorporate into your own programs

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The most powe
compil

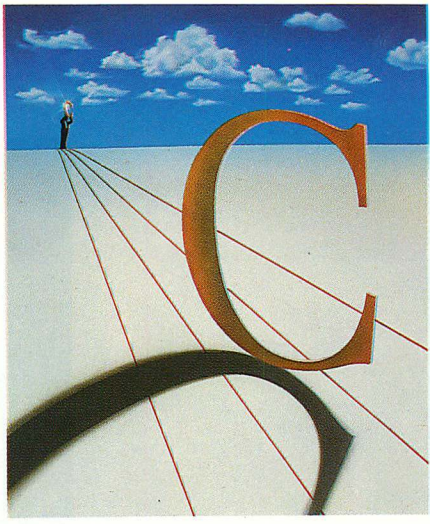
Our new Turbo C generates fast, tight, production-quality code at compilation speeds of more than 13,000 lines a minute!

It's the full-featured optimizing compiler everyone has been waiting for.

Switching to Turbo C, or starting with Turbo C, you win both ways

If you're already programming in C, switching to Turbo C will make you feel like you're riding a rocket instead of pedaling a bike.

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> "Turbo C does look like What We've All Been Waiting For: a full-featured compiler that produces excellent code in an unbelievable hurry . . . moves into a class all its own among full-featured C compilers . . . Turbo C is indeed for the serious developer . . . One heck of a buy—at any price."
>
> *Michael Abrash, Programmer's Journal*

) C: NEW! rful optimizing r ever

Sieve benchmark

	Turbo C	Microsoft® C
Compile time	*2.4*	13.51
Compile and link time	*4.1*	18.13
Execution time	*3.95*	5.93
Object code size	*239*	249
Execution size	*5748*	7136
Price	*$99.95*	$450.00

Benchmark run on an IBM PS/2 Model 60 using Turbo C version 1.0 and the Turbo Linker version 1.0; Microsoft C version 4.0 and the MS overlay linker version 3.51.

Technical Specifications

- ☑ Compiler: One-pass optimizing compiler generating linkable object modules. Included is Borland's high-performance Turbo Linker.™ The object module is compatible with the PC-DOS linker. Supports tiny, small, compact, medium, large, and huge memory model libraries. Can mix models with near and far pointers. Includes floating point emulator (utilizes 8087/80287 if installed).
- ☑ Interactive Editor: The system includes a powerful, interactive full-screen text editor. If the compiler detects an error, the editor automatically positions the cursor appropriately in the source code.
- ☑ Development Environment: A powerful "Make" is included so that managing Turbo C program development is highly efficient. Also includes pull-down menus and windows.
- ☑ Links with relocatable object modules created using Borland's Turbo Prolog into a single program.
- ☑ Inline assembly code.
- ☑ Loop optimizations.
- ☑ Register variables.
- ☑ ANSI C compatible.
- ☑ Start-up routine source code included.
- ☑ Both command line and integrated environment versions included.
- ☑ License to the source code for Run-time Library available.

Join more than 100,000 Turbo C enthusiasts. Get your copy of Turbo C today!

Minimum system requirements: All products run on IBM PC, XT, AT, PS/2, portable and true compatibles. PC-DOS (MS-DOS) 2.0 or later. 384K RAM minimum. Basic Telecom and Editor Toolboxes require 640K.

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Telephone: (408) 438-8400 Telex: 172373

Why more than 600,000 programmers worldwide are using Turbo Pascal today

The irresistible force behind Turbo Pascal's worldwide success is Borland's advanced technology. We created a compiler so fast, that Turbo Pascal® is now the worldwide standard. And there are more tools for Turbo Pascal than for any other development environment in the world.

You'll get everything you need from Turbo Pascal and its 5 Toolboxes

Turbo Pascal and Family are all you'll ever need to perfect programming in Pascal.

If you've never programmed in Pascal, you'll probably want to start with Turbo Pascal Tutor® 2.0, and as your expertise quickly grows, add Toolboxes like our

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- Editor Toolbox®
- Graphix Toolbox®
- GameWorks®

and our newest,

- Numerical Methods Toolbox™



And because Turbo Pascal is the established worldwide standard, 3rd party, independent non-Borland developers also offer an incredible array of programs for Turbo Pascal. ***Only $99.95!***

"Borland International's Turbo Pascal took the programming world by storm. A great compiler combined with a good editor at an astounding price, the package quickly came to be called, simply, Turbo—and has sold more than 500,000 copies.

Stephen Randy Davis, PC Magazine

Language deal of the century. *PC Magazine*"



For Scientists and Engineers: Turbo Pascal Numerical Methods Toolbox

The Numerical Methods Toolbox is a complete collection of Turbo Pascal routines and programs. Add it to your development system and you have the most comprehensive and powerful numerical analysis capabilities—at your fingertips!

The Numerical Methods Toolbox is a state-of-the-art mathematical toolbox with these ten powerful features:

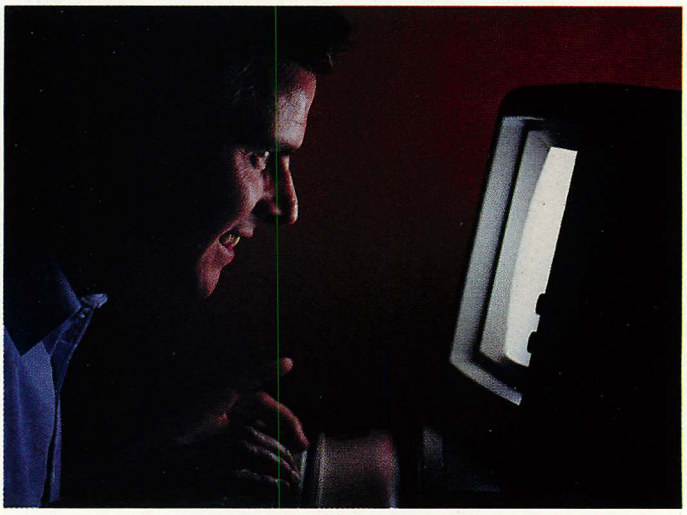
- ☑ Zeros of a function
- ☑ Interpolation
- ☑ Differentiation
- ☑ Integration
- ☑ Matrix Inversion
- ☑ Matrix Eigenvalues
- ☑ Differential Equations
- ☑ Least Squares
- ☑ Fourier Transforms
- ☑ Graphics

Each module comes with procedures that can be easily adapted to your own program. The Toolbox also comes complete with source code. So you have total control of your application.

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Turbo C, Turbo Basic, Turbo Pascal and Turbo Prolog: technical excellence



"Borland International's Turbo Pascal, Turbo Basic and Turbo Prolog automatically identify themselves, by virtue of their 'Turbo' forenames, as superior language products with a common programming environment. The appellation also means to many PC users a 'must have' language. To us Turbo C looks like a coup for Borland."

Garry Ray, PC Week"

Turbo Basic introduces its powerful new Telecom, Editor and Database Toolboxes

NEW!

Turbo Basic® is the breakthrough you've been waiting for. The same power we brought to Pascal with Turbo Pascal has now been applied to BASIC with Turbo Basic.

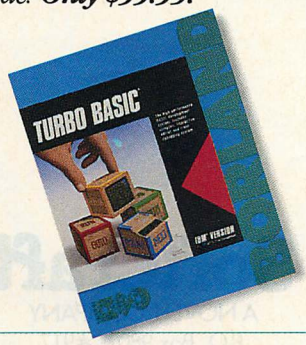
Compatible with BASICA, Turbo Basic is the high-performance, high-speed BASIC you'd expect from Borland.

> "Borland has created the most powerful version of BASIC ever."
> *Ethan Winer, PC Magazine*

Basically, Turbo Basic is all you need

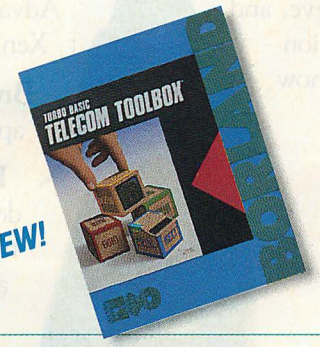
It's a complete development environment which includes an incredibly fast compiler, an interactive editor and a trace debugging system. It outperforms all its rivals, and because it's compatible with BASICA, you probably already know how to use it.

Includes a free MicroCalc™ spreadsheet complete with source code. ***Only $99.95!***



A technical look at Turbo Basic

- ☑ Full recursion supported
- ☑ Standard IEEE floating-point format
- ☑ Floating-point support, with full 8087 (math co-processor) integration. Software emulation if no 8087 present
- ☑ Program size limited only by available memory (no 64K limitation)
- ☑ VGA, CGA, and EGA support
- ☑ Access to local, static, and global variables
- ☑ Full integration of the compiler, editor, and executable program, with separate windows for editing, messages, tracing, and execution
- ☑ Compile, run-time, and I/O errors place you in the source code where error occurred
- ☑ New long integer (32-bit) data type
- ☑ Full 80-bit precision
- ☑ Pull-down menus
- ☑ Full window management



NEW!

Telecom Toolbox is a complete communications package which takes advantage of the built-in communications capabilities of BASIC—use as is or modify.

- Pull-down menus and windows
- XMODEM support
- VT 100 terminal emulation
- Captures text to disk or printer
- PhoneBook file
- 300, 1200, 2400 baud support
- Supports script files
- Fast screen I/O
- Supports most of XTalk's command set
- Manual dial and redial options

Use Telecom Toolbox to embed communications capabilities into your own programs and/or build your own communications package. Source code included for all Toolbox code and sample programs. ***Only $99.95!***

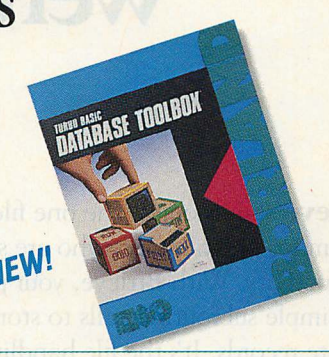
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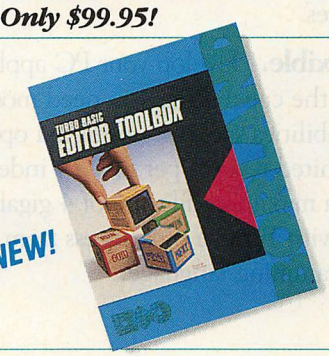


NEW!

Database Toolbox means that you don't have to reinvent the wheel each time you write new Turbo Basic database programs.

- ☑ "Trainer" shows you how B+ trees work. (Simply key in sample records and you'll see your index being built.)
- ☑ Turbo Access instantly locates, inserts or deletes records in a database—using B+ trees.
- ☑ Turbo Sort sorts data on single items or on multiple keys and features virtual memory management for sorting large data files.

Source code included.
Only $99.95!



NEW!

Editor Toolbox is all you need to build your own text editor or word processor. Includes source code for two sample editors.

First Editor is a complete editor ready to include in your programs, complete with windows, block commands and memory-mapped screen routines.

MicroStar™ is a full-blown text editor with a complete pull-down menu user interface, and gives you

- Wordwrap
- Undo last change
- Auto-Indent
- Find and Find/Replace with options
- Set left/right margins
- Block mark, move and copy
- Tab, insert, overstrike modes, line center etc.

Includes source code.
Only $99.95!

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If you thought all file managers were alike, think again. Think Btrieve.

Btrieve stands out as the one file management system for programmers who are serious about productivity. With Btrieve, your programs can use simple subroutine calls to store, retrieve, and update records. It's the file handling solution rich in functionality to meet your needs now and in the future, as your requirements grow and change.

Bfast. With Btrieve you develop fast applications, with ease. Written in assembly language for IBM PC's, Btrieve uses b-tree algorithms with automatic balancing for fast, efficient file indexing.

Bsafe. Btrieve is the only file manager with automatic file recovery. Two levels of database integrity provide complete fault tolerance in the event of accidents or power failures.

Bflexible. Develop your PC applications with the capabilities you need most. Capabilities such as: unlimited open files, unlimited records per file, 24 indexes per file and a maximum file size of 4 gigabytes. All this with Btrieve plus access from any programming language.



Bconnected. When your applications require networking, think Btrieve. A single version runs on all DOS 3 LAN's, including IBM PC Network and Novell Advanced NetWare. Btrieve is also available for Xenix and other multi-tasking operating systems.

Broyalty Free. No royalty payments on your applications. Ever.

Bsure. Btrieve comes with comprehensive documentation and unrivaled technical support for trouble-free software development. And you can add Xtrieve to supply your end users with even more, a menu-driven report writer and query system.

Think Btrieve. Make your programming performance stand out. Contact SoftCraft.

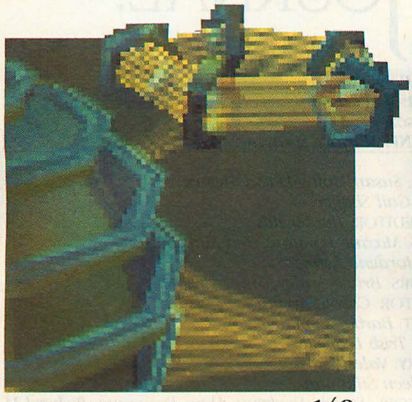
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Btrieve, $245; multi-user Btrieve, $595; Xtrieve, $245;
multi-user Xtrieve, $595 (for report generation, add $145 for single-user and $345 for multi-user).
Requires PC-DOS or MS-DOS 2.X, 3.X or Xenix. Btrieve and Xtrieve are registered trademarks of SoftCraft Inc.

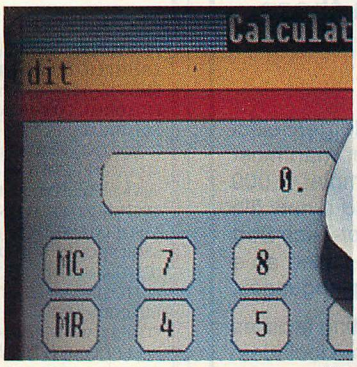
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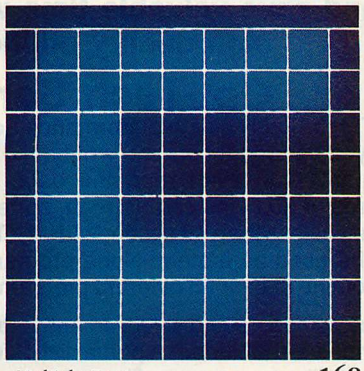
OCTOBER 1987 VOLUME 5, NUMBER 10



Gateways to System/3x **148**



Windows Virtual Machine **90**



Multiple Fonts **168**

ANALYZING NETWORK TRAFFIC / J. SCOTT HAUGDAHL
The Sniffer from Network General unravels mysteries of the local area network. What does the traffic on the LAN look like? Where is it going? Does it adhere to a standard protocol? The product targets both the Token-Ring Network and Ethernet for investigation. 48

WINDOWS MEMORY MANAGEMENT / GUY QUEDENS and STEVEN ARMBRUST
Developers familiar with Microsoft Windows may be a step ahead when the time comes to move to OS/2 and its user interface, the Presentation Manager. Techniques for managing memory will be among the concepts that carry over from Windows to OS/2. 66

WINDOWS VIRTUAL MACHINE / GUY QUEDENS
Hardware independence is the key to Windows' device driver support. Windows applications are immune to changes to DOS and hardware. Taking advantage of this device independence will help developers create applications for OS/2, as well as Windows. 90

A DATA MANAGER WITH LANGUAGE FLEXIBILITY / BURKS A. SMITH
The team of Btrieve and Xtrieve from SoftCraft offers an alternative to fourth-generation languages designed specifically for data management. Btrieve can work with familiar programming languages, while Xtrieve adds query and report capabilities. 104

A DATA MANAGER THAN ELIMINATES PROGRAMMING / VICTOR E. WRIGHT
Aker Corporation adopted Btrieve into its product, MAGIC PC, to create a data manager that requires no procedural programming. MAGIC PC uses a "database engine" with rules designed by the developer to infer ways to handle typical data management tasks. 122

GATEWAYS TO SYSTEM/3X / GERRY KAPLAN
You have PCs that you want to connect to a System/3x for occasional use. Among your choices for connection are three 5251 gateway packages: the Asher MiniLink, AST 5251 Plus, and IDEAcomm 5251. Two have sluggish performance; one stands out. 148

MULTIPLE FONTS / JOHN T. COCKERHAM
Hercules Computer Technology jars the graphics market again—this time with graphics boards that can display a dozen fonts in text mode at one time. The Graphics Plus Card and InColor should be especially appreciated in the desktop publishing field. 168

9 DIRECTIONS
Protective Shells

15 LETTERS

30 TECH RELEASES

45 TECH NOTEBOOK
DOS Memory Control

189 PRODUCT WATCH
BRIEF
Carbon Copy Plus
EGA WONDER

201 EXPERT CONSULTANT: *HUMAN FACTORS*
A Good Answer

205 READER SERVICE CARD

212 TECH MARKETPLACE

222 CALENDAR

Cover illustration · Nenead Jakesevic

Software Tools

For Programmers & Non-Programmers

Get 'State of the Art' performance and save valuable time with these high quality utilities!

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Opt-Tech Sort is a high performance Sort/Merge/Select utility. It can read, sort and write a file faster than most programs can even read the data. Example: 1,000 records of 80 bytes can be read, sorted and a new file written in less than 10 seconds (IBM XT). Opt-Tech Sort can be used as a stand-alone program or called as a subroutine to over 25 different programming languages.

All the sorting, record selection and reformatting facilities you need are included. A partial list of features includes: The ability to process files of any size. Numerous filetypes are supported including Sequential, Random, Delimited, Btrieve, dBASE II & III and many others. Up to 10 key fields can be specified (ascending or descending order). Over 16 different types of data supported. Powerful record selection capability allows you to specify which records are to be included on your output. Record reformatting allows you to change the structure of your output record and to output special fields such as record numbers for use as indexes.

MS-DOS $149. ★ NEW ★ Xenix $249.

★ NEW ★ VERSION

On-Line Help™

★ NEW ★ VERSION

On-Line Help allows you to easily add "Help Windows" to all your programs. On-Line Help is actually two help packages in one. You get BOTH Resident (pop-up) and Callable Help Systems.

The resident version allows you to add help to any system. Your Help System is activated when the "Hot Keys" that you specify are pressed. You can then chain between help windows in any manner you desire.

The callable version allows you to easily display help windows from your programs. A simple call to the help system makes the window appear. The original screen is automatically restored when the help window is cleared. On-Line Help is callable from over 20 different languages.

You have full control over the help window content, size, color and location.

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Scroll & Recall is a resident screen and keyboard enhancement. It allows you to conveniently scroll back through data that has gone off the top of your display screen. Up to 27 screens of data can be recalled or written to a disk file (great for documenting systems operations). Also allows you to easily recall and edit your previously entered DOS commands without retyping.

Scroll & Recall is very easy to use. It's a resident utility that's always there when you need it. MS-DOS $69.

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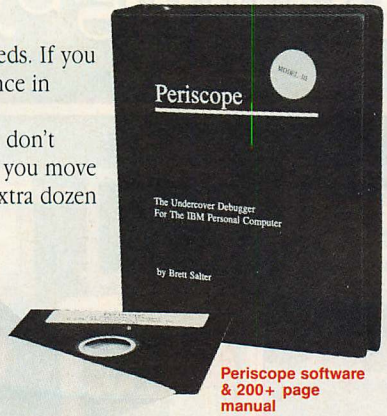
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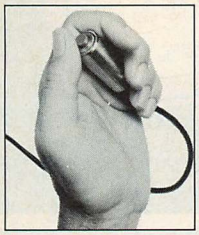


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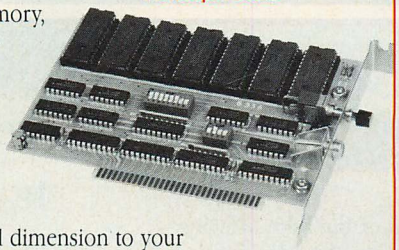
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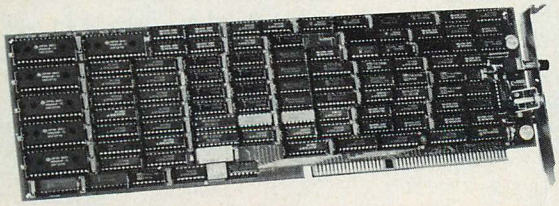
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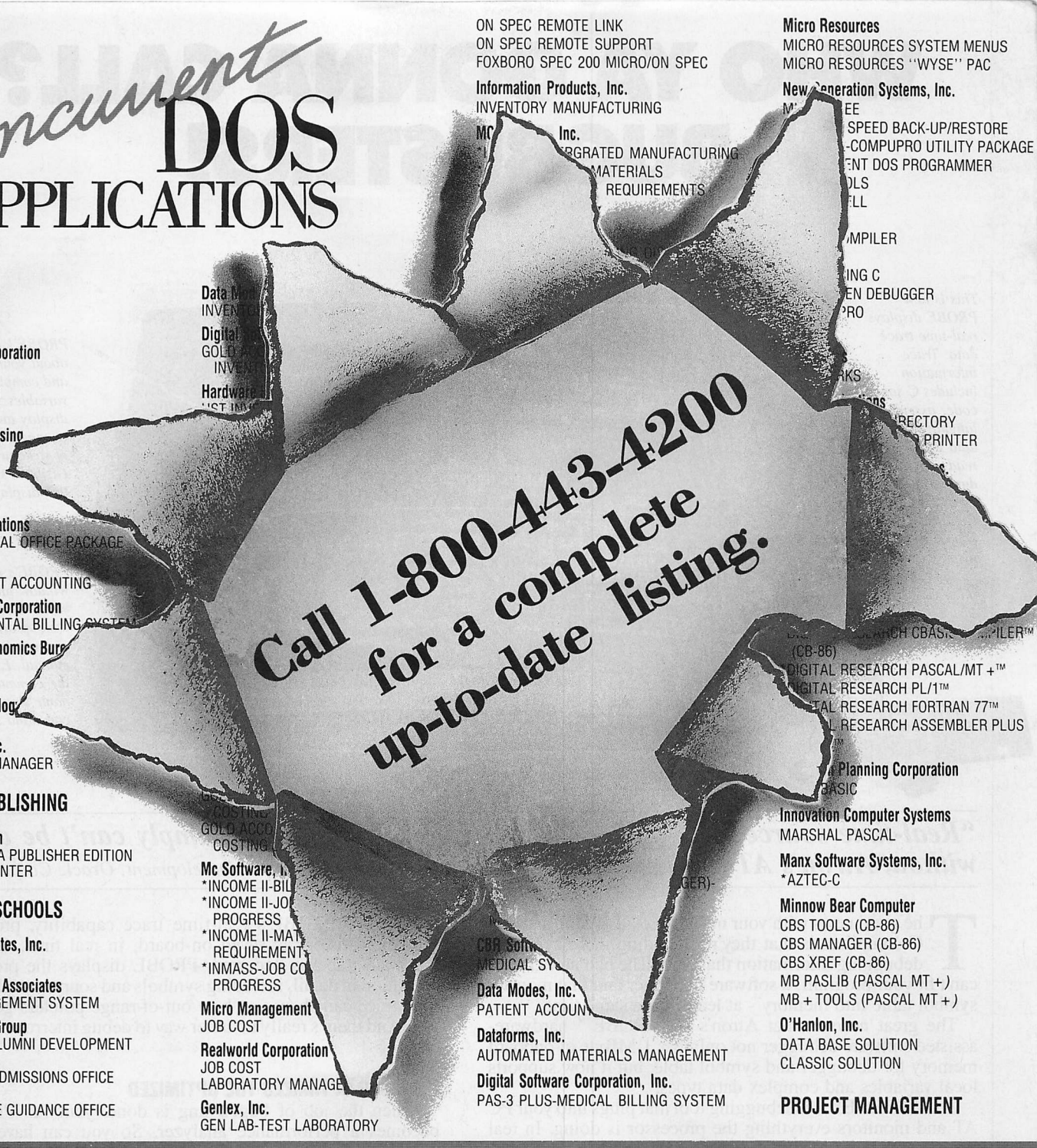
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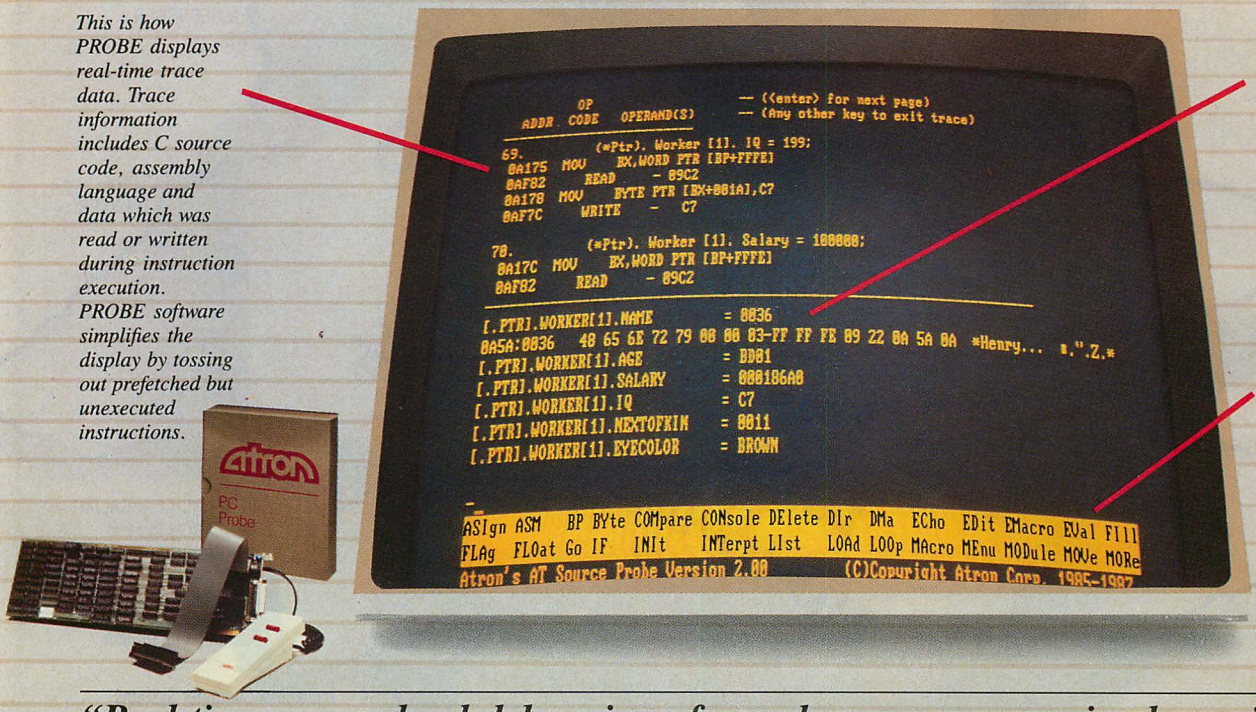
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Protective Shells

Hiding DOS's command processor from the user is becoming more desirable.

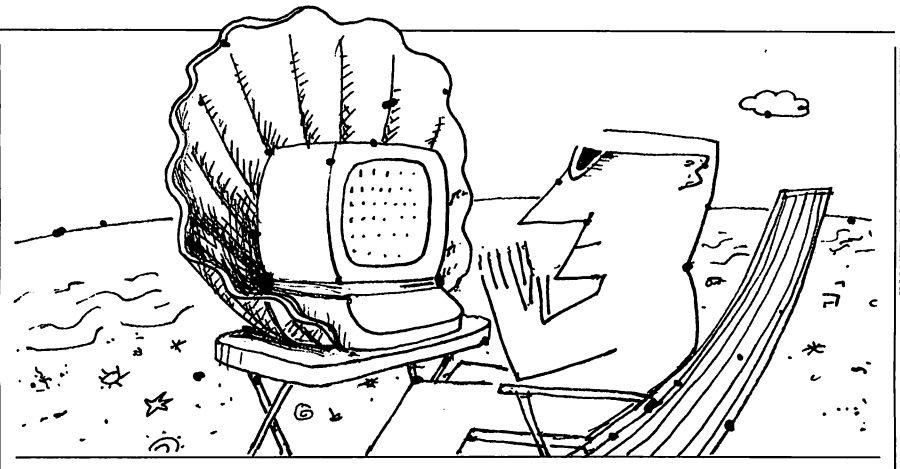


ILLUSTRATION • MACIEK ALBRECHT

Interest is growing in the class of programs known as shells—programs that wrap themselves around DOS and provide either an alternative user interface to system functions or extensions to the capabilities of the DOS command line, or both. Interest is especially high where local area networks are involved, because of the additional complexity that LANs sometimes bring to the end user.

Theoretically, the bigger shells, commonly called *environments* (Microsoft Windows, Digital Research's GEM, and the OS/2 Presentation Manager), represent the ultimate solution to both user interface problems and the rising complexity of computer operations. Most shells, however, offer dramatic simplification when compared to a program like Windows.

Generally speaking, shells perform four major functions:

- **DOS simplification.** Although most computer professionals do not have difficulty comprehending and using the DOS command line, DOS is often a mystery to end users. Shell programs try to reduce the mystery by offering DOS functionality in understandable terms and by removing the command-line cryptography from the process. Sophisticated users can benefit by using shells to automate common tasks involving numerous and/or complicated commands.
- **File system navigation.** Maneuvering around the file system on a hard disk can be difficult, even for experienced users. Shells usually provide a visual metaphor for navigating through the file system and can simplify the process even further by allowing the user to see only a particular type of file, such as Lotus 1-2-3 .WKS/.WK1 files. Some shells, such as Executive Systems' Xtree and Bourbaki's 1dir+, offer a visual representation of the directory tree structure that can be traversed with the cursor keys. More important, most shells allow a group of files to be marked so that a particular command can be applied. For example, a group of files with dissimilar names and extensions can be copied as a group.
- **Program execution.** Shells often provide some mechanism to begin the execution of another program. The common strategy is a system using menus that can be customized by the end user or crafted for a larger group by a developer. Most shells can either start a program or cause DOS to interpret a procedure (.BAT) file. The shell programs can store the dizzying array of options that many programs need, leaving the user with nothing more to do than to select a single menu entry.
- **Context switching.** Very few shells, other than environments such as Windows, offer context switching. While the other three functions of shells represent nothing more than a different user interface than DOS provides, context switching represents a significant extension to the operating system. The shell can load multiple programs into memory, not just one, and can then allow the user to move among them at will.

Environments provide at least one benefit that ordinary shell programs do not; they add multitasking capabilities, allowing programs to operate concurrently. Windows and Quarterdeck's DESQview, for example, have attracted some developers who want to build systems that require multitasking; a significant number of users, however, exploit only the context-switching capabilities inherent in these products.

A good example of a shell with all four features is the WordPerfect SHELL program, included in the WordPerfect Library. SHELL reduces starting a program to one keystroke, provides context switching, (even to non-WordPerfect Corporation programs), and allows many programs to fit in RAM by swapping idle programs into expanded memory, thus freeing the lower 640KB for the active application. Access to an application on a LAN is no different; once configured, a single keystroke brings it up. The WordPerfect Library also includes a file manager that, with SHELL, provides almost total control of the DOS environment, but avoids the necessity of typing commands.

WordPerfect itself, as well as most other word processors and many DOS-based applications, provides a similar level of DOS control from within its own environment. The file manager is built in, and the user can perform most tasks except formatting a disk.

For those direct DOS functions that are an absolute necessity, most programs today can transfer control to the DOS command processor, then return to the program and resume work at the same spot. The application could be considered a shell; Lotus intends to exploit this concept by offering applications that become part of the 1-2-3 environment. Therefore, a secretary's "shell" might be a word processor, while a budget planner's "shell" might be a spreadsheet program.

Besides the WordPerfect SHELL, two other popular shell programs are the aforementioned 1dir+ and the Norton Commander from Peter Norton Computing. The Norton product is a bit leaner and nicely complements, rather than replaces, the command line. Both programs, however, provide file system navigation using the point-and-shoot metaphor and a menuing system that allows one- or two-key program execution. 1dir+ is somewhat richer, especially with its built-in support for constructing menus; the Norton Commander operates from text files created with an editor (Commander does have a built-in editor). The primary difference between these products and WordPerfect's SHELL is the latter's ability to provide context switching.

In short, programs of this type protect the user by hiding complex DOS details and simplifying others, such as the file system.

WHITHER SHELLS?

Dwelling on shells may seem foolish in light of the sophistication of Windows, DESQview, and GEM, and particularly in light of the advent of OS/2 and the Presentation Manager. That, however, is the point. The availability of the OS/2 Presentation Manager has not yet been announced and we can thus safely assume that it is still quite a way off. OS/2 itself offers little improvement over the DOS command line, so shell programs will afford needed protection to the innocent end user.

More important, context switchers such as WordPerfect's SHELL can be extended to support the OS/2 environment by providing a user interface to manage concurrent tasks. The other functions provided by shell programs will be just as welcome, maybe more so, in the new, more complicated operating environment.

In fact, shells can help larger companies deal with the transition from DOS to OS/2 by presenting a consistent user interface for both operating systems. Although this is a much-touted benefit of Windows, most shell programs require substantially fewer system resources (especially memory) than do full-scale environments. That is a particular benefit for large firms with substantial populations of 8088-based computers. Shell programs also offer some integration of applications without the need to convert those applications to the complex Windows or Presentation Manager application programming interface (API).

I am a big believer in a common, graphical user interface. Windows 2.0 is a significant improvement (in performance) over Windows 1.0x. However, mainstream applications are not written to the Windows or Presentation Manager API and will not be for some time, so other solutions must be considered in the interim. These shell programs are good ways to hedge our bets until the OS wars settle down and the applications begin to migrate to the important new environments.

THE PREMIUM'S DISCOUNT PREMIUM

Lately, quite a few people have been asking me what computer they should buy. In all cases, the amount of money is limited and clashes with the desire for the most contemporary system possible. The degree of concern about reliability and maintainability is significant. In short, these potential buyers want the best system for the least money but still want good, fast support if problems arise.

Current technology usually demands premium prices. The ultimate technical solution is a 386-based computer because it offers the greatest possibility of a long software life. Today, it can be used as a fast 8088; next week, as a fast 80286; ultimately, it can take advantage of new operating software, creative and powerful tools, and advanced applications.

Once again, however, the desirability of a 386-based solution meets the checkbook head-on. True, many opportunities exist to buy low-cost, mail-order 386 machines, but often these do not offer a satisfactory level of support. For someone who lives and works away from the city, the inability to obtain local service means potential downtime.

One way around this problem is a machine that *PC Tech Journal* has previously reviewed: AST's AT-compatible Premium/286 (see "Out from the Shadow of IBM: Premium/286," Steven Armbrust and Ted Forgeron, June 1987, p. 74). In that review, we praised the machine for its compatibility and high performance and pointed to its extraordinarily low price, considering the fact that it is sold through normal dealer channels and is fully supported. Our daily experience with the Premium/286 has given us a strong confidence in the reliability of the AST solution.

When AST announced the Premium/286, the company privately showed *PC Tech Journal* a prototype add-in 386 coprocessor board that could be plugged into one of the machine's FASTslots. At the time AST could not say when this option would be announced. We believe that it will be available soon—surely by Fall COMDEX. This 386 option is a key reason why the Premium/286 deserves consideration.

The significance of this upgrade path should be clearly understood. The AST Premium/286 is the only 286-based desktop machine that has been *specifically* designed and engineered to support this upgrade. Unlike the Intel InBoard/386, which had to be designed to compensate for the limitations and idiosyncracies of the underlying AT or compatible, AST's solution meshes cleanly when it is plugged into its host. A side effect is that AST's board should be slightly less expensive than the InBoard/386.

One aspect of AST's approach raises some questions about compatibility; the 80286 remains when the 80386 is installed. (See "Speed Infusion, Part 3," Ted Mirecki, June 1987, p. 118, for a discussion of the coprocessor approach to accelerators.) This may require AST-supplied versions of OS/2 or other environments; the same may be true for other vendors (Intel's Inboard/386).

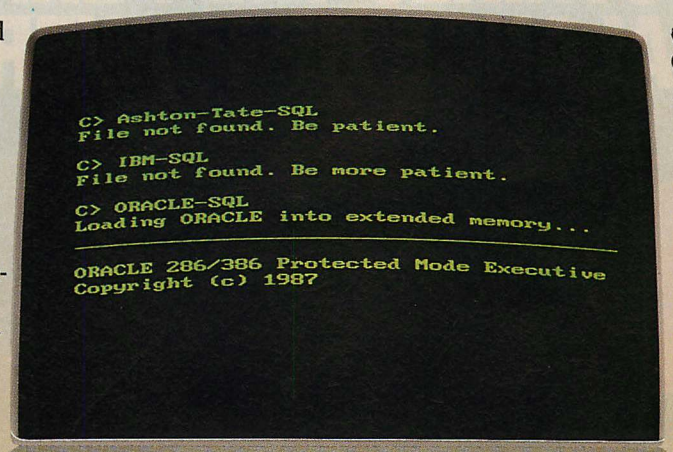
Nonetheless, this option will be a tour de force for the Premium/286. This is a clear indication that architectures other than the original PC standard and the new PS/2 standard have a place in the market, and that such alternative architectures do not necessarily preclude IBM compatibility at the software level.

—*WF*

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*PC ORACLE requires an "OS/2 ready" 286/386-based PC running DOS 3.1+ with 1MB extended memory (2MB is recommended) and a minimum 10MB hard disk drive.
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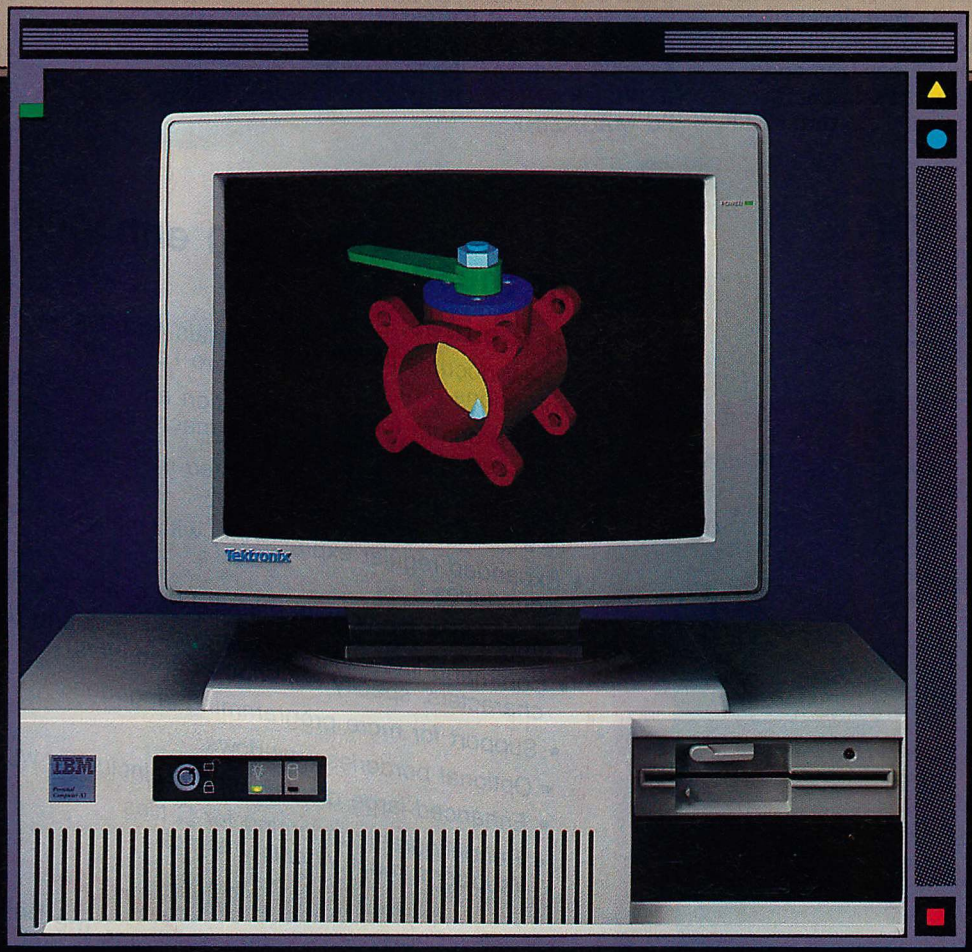
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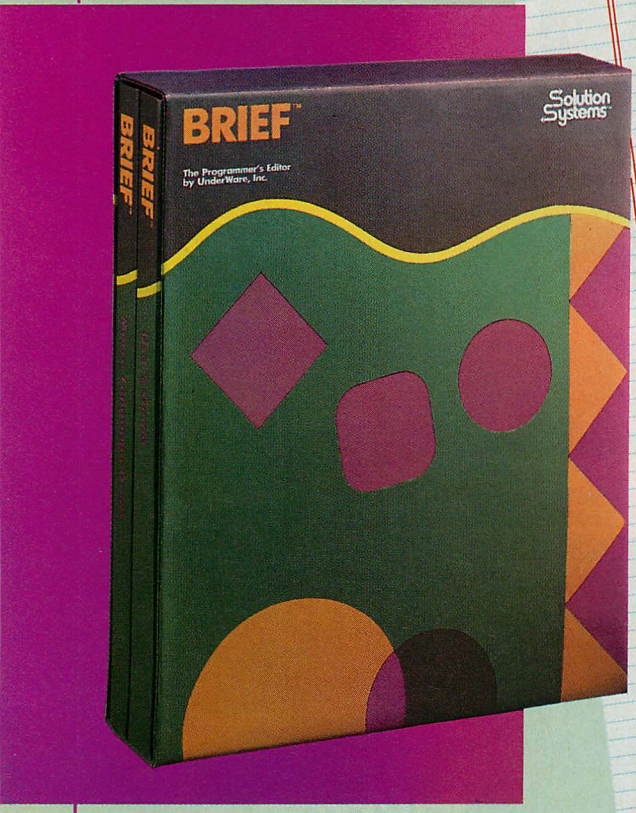
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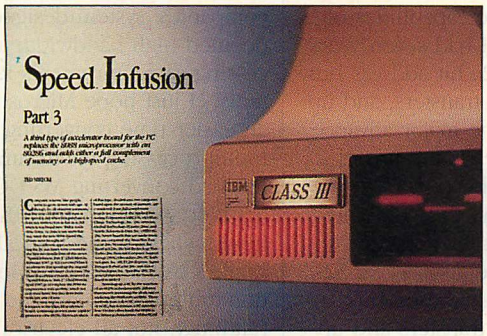
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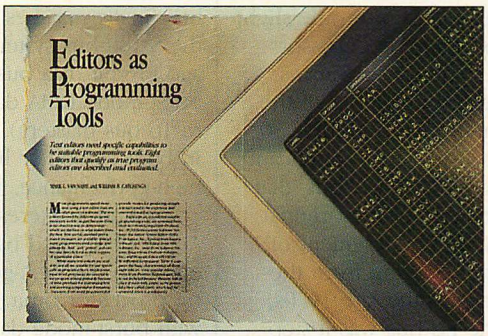
Requires an IBM PC or compatible with at least 192K RAM.

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CIRCLE NO. 130 ON READER SERVICE CARD





SPEED ADJUSTMENT

I found Ted Mirecki's article "Speed Infusion, Part 3" (June 1987, p. 118) to be quite informative. The Breakthru 286 by Personal Computer Support Group (PCSG) immediately stood out not only for its performance but for its $395 price tag. However, PCSG advertisements indicate this board only runs at 8 Mhz, contrary to your article, which claims 12 MHz. Is it possible that you actually reviewed the Breakthru 286-12, a 12-MHz version of the same board, which costs $595—essentially the same as its competition?

Rod S. March
Fairbanks, AK

It was indeed the 12-MHz version that was reviewed, although the early packaging gave no such indication. In addition, the price was entered incorrectly during editorial production. PC Tech Journal *regrets the error.*

—TM

CORRECTIONS, BRIEFLY

Your review of BRIEF, the Programmer's Editor, in the May 1987 issue ("Editors as Programming Tools," Mark L. Van Name and William B. Catchings, p. 160) appraises the product fairly regarding its ease of use, power, and appeal to a large class of users.

However, I must respond to the authors' strong stand on compatibility with other environments. What BRIEF offers is an editor without bias. Users can tailor BRIEF to their personal programming style—change key assignments, commands, prompts, colors, even indenting styles. In addition, the article contained several errors:

1. BRIEF *does* have a "delete to end of file" command.
2. Undo *will* restore a changed or deleted line.
3. Tab characters *can* be stored as spaces in the file by using the **−t** start-up flag.
4. Word wrap *is* provided in the word processing mode.

It was surprising to read that an outdated copy of BRIEF (version 1.3, last shipped in August 1985) was used for review instead of the (then) current version 1.33 Solution Systems product, sent to *PC Tech Journal*. Most of the review tables and benchmarks are, therefore, inaccurate.

In fact, the reviewers were contacted regarding the upcoming major revision of BRIEF version 2.0 and prerelease documentation was sent. Version 2.0 is a substantial upgrade that has many improvements in speed, documentation, configurability, and ease of learning. We announced BRIEF 2.0 in an advertisement in the same issue (yet the new version was not even acknowledged in this review of editors). Although it is an editorial policy not to review a prerelease copy of the software, it is common to mention an upcoming release.

Steve Barnette
Solutions Systems
South Weymouth, MA

Compatibility with other environments was determined in an editor's standard configuration straight out of the box. BRIEF *is certainly very adaptable, and can be reconfigured to replicate reasonably closely the command structures of many other editors and word processors. However, this is not a trivial exercise. The type of user most uncomfortable with a new command structure would be least likely to undertake a major programming project to convert the editor to his specifications, especially if an editor with the desired interface already exists.*

The table entries for commands to delete to end of line, store tabs as spaces, and wrap words were misprints; all of these capabilities are in fact present in BRIEF. *In addition, we note that the version actually tested was 1.33; the wrong version number was printed. We regret these errors.*

However, the entry for restoring a changed line is correct. The "restore line" feature refers to a single command that undoes at once all the changes made on a single line. This is not the same as undoing changes one by one. First, the undo sequence is less convenient because it includes even nondestructive changes such as cursor moves, and second, it may not allow complete restoration because the number of changes on a line may exceed the depth of the undo stack. The lack of this capability is not in itself a fault, because overall, BRIEF*'s undo capability is easily the best of all the editors tested.*

It is PC Tech Journal*'s policy to mention upcoming product releases only to the extent that they address shortcomings of the version being reviewed. This was done when it was mentioned that the faults of the* BRIEF *version 1.33 manual (one of the very few shortcomings of this editor) were to be corrected in the next release. My review of* BRIEF *version 2.0 appears in this month's Product Watch (p. 189).*

—TM

ATTACK STRATEGIES

This letter is in response to your reader query on the importance of the Macintosh machines, specifically the Macintosh II ("Mac II Attack," Directions, Will Fastie, June 1987, p. 9). I have an "intuitively obvious" solution to the IBM versus Apple dilemma: take the best of both worlds.

First I must publicize my prejudices. I am biased against proprietary hardware and operating systems. I prefer to minimize my reliance on a single vendor, hardware or software. I prefer the creative, competitive environment produced by an open industry.

Second, I consider the IBM PS/2 Model 80 and the Macintosh II the only *significant* new machines in their re-

spective product lines. The IBM Model 30 and the Macintosh SE are only slight improvements on their predecessors and provide no significant advances. Even though the 16-bit version of the IBM Micro Channel bus in Models 50 and 60 can be considered a significant improvement over the PC/AT bus, that is more an indictment of the original IBM PC bus than an endorsement of the Micro Channel. Moving from the S-100 bus standard of the late 1970s, early 1980s to the PC bus was a step *backward*. The 16-bit Micro Channel bus finally matches the capabilities of the S-100 bus system I had seven years ago (16-bit data bus, 24-bit address bus, burst-mode DMA data transfers, and up to 16 bus masters). The major advance in both computer lines is the use of a high-performance, 32-bit bus.

I find it interesting that IBM and Apple developed basically the same solution to the next-generation PC: a 32-bit processor on a 32-bit-based bus with burst-mode data transfers and up to 16 alternating bus masters. Both companies' system designers must have deemed high bandwidth and multiprocessing as requirements for future systems. (I just hope Microsoft will have an easier time converting OS/2 to a multiprocessing environment than it has had converting MS-DOS to a multitasking environment.) IBM seems to have a slight technological edge over Apple's NuBus standard in that it has non-multiplexed data and address lines (although not all electrical engineers agree that this provides a significant performance increase). But then, the Macintosh NuBus is nonproprietary whereas IBM has been threatening lawsuits for anyone trying to clone their Micro Channel.

This brings me to my solution to choosing between IBM and Apple: use the Apple NuBus as the hardware standard and IBM's (or rather Microsoft's) OS/2 as the operating system standard (with UNIX/X-Windows a close second). This avoids the proprietary nature of Apple's operating system and IBM's Micro Channel bus, creating a truly open, high-performance system.

Personally, I would buy such a system, but then one buyer does not a market make. But my desire for a nonproprietary hardware/software architecture and a competitive environment is shared by many individual computer buyers and companies, including the "company" I work for, the United States government.

Michael H. Cox
Alexandria, VA

Will Fastie's "Mac II Attack" neglects a few key facts. If these facts are taken into account, the Mac II looks a lot less attractive for business use.

The most significant problem with the Mac (of any flavor) is the lack of error checking in the bus and memory. Even a simple parity check would be an improvement, but for what you have to pay for the Mac II, you really are entitled to full-fledged ECC (error-correcting code).

Local area networks frequently are used for such functions as file sharing, where the transfer rate must be rapid to allow adequate performance. In these applications, a high bandwidth on the backbone LAN does no good if you cannot get data into and out of the backbone expeditiously. Putting the low-performance AppleTalk interface into the Mac II should be counted as a fault rather than a feature: it is useless, drives up the price, and takes up space



CIRCLE NO. 185 ON READER SERVICE CARD

MICROSOFT LANGUAGES NEWSLETTER VOL. 2, NO. 10

News about the Microsoft Languages Family

Optimizing Your Programs with the Microsoft® C Optimizing Compiler Version 5.0

Fast execution speed is the single most important feature of a C compiler. Volume 2, Number 2 of the Microsoft Languages Newsletter talked about the optimizations available in Microsoft C Version 4.0. Microsoft C Version 5.0 takes these optimizations further. For example,

```
for (i = 0; i < 25; i++)          becomes          tmp = a*b;
        array[i] = a*b;                            for (i = 0; i < 25; i++)
                                                       array [i] = tmp;
```

Since a and b are not affected by the loop, they are moved outside of the loop. This optimization is called *invariant code motion.* The Microsoft C Optimizing Compiler also uses instructions available on the 8086 to optimize specialized loops. Initialization and memory movement loops are two examples. The optimizer generates REP STOSW and REP MOVSW instructions for

```
int i, x[25];                     and              int i, x[25], y[25];
for (i = 0; i < 25; i++)                           for (i = 0; i < 25; i++)
        x[i] = 0;                                          x[i] = y[i];
```

The following example is more complicated. The optimizer rewrites array references as pointer references because they are more efficient.

```
int i, x[25];                     becomes          int i, x[25], *ptr;
for (i = 0; i < 25; i++)                           for (i = 0, ptr = x; i< 25; i++, ptr++)
        x[i] = i*4;                                        *ptr = i*4;
```

Then the optimizer puts key variables in registers using *loop enregistering* and changes the loop incrementation using a process called *strength reduction.* The loop becomes

```
int i, x[25];
i = 25;
{
        register int j;
        register int *ptr;
        for (j = 0, ptr = x; j < 100; j + = 4, ptr++)
                *ptr = j;
}
```

The final form of the loop uses registers for key values and exchanges addition instructions for multiplication instructions. Here is the output of the Microsoft C Optimizing Compiler in 8086 assembly code.

```
        mov     WORD PTR [bp-52], 25        ; set final value of i to 25
        mov     di,bp
        sub     di,50                       ; load pointer to x
        sub     si,si                       ; set temporary register variable to 0
                                            ; this variable is used as the loop counter
$L20000:
        mov     WORD PTR [di], si           ; set the array value
        add     di,2                        ; increment pointer by 2
        add     si,4                        ; increment loop counter by 4
        cmp     si,96                       ; check if we are at the end of the loop
        jle     $L20000
```

What is the result of these optimizations? Programs compiled with Microsoft C Version 5.0 run 15 to 30 percent faster than those compiled with Version 4.0.

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in back that could have been used for something more desirable.

The much vaunted user interface of the Mac is a mixed blessing. The heavy use of bit-mapped graphics begs for a hardware assist, but the Mac does it all in software. Further the application interface requires programs to waste additional cycles in polling, instead of using a more sophisticated approach, such as software interrupts. Finally, Apple seems to believe that anything you can do with a mouse, you *should* do with a mouse, so they did not put function keys on the keyboard, yet many users find function keys far more convenient.

Apparently, the folks who brought out "the computer for the rest of you" have more than simply a trace of "Big Brother" and they think that the rest of you should march in lockstep. The Mac II does *not* use an industry-standard bus. The NuBus is an MIT specification, and I know of no standards body that has picked it up. It is not used enough to consider it a de facto standard. And, most important, the Mac II does not use a true NuBus, since the Mac II neither supplies, nor checks parity.

The Mac II may be a good start, but it has not "arrived" as yet.

Seymour J. Metz
Annandale, VA

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CIRCLE NO. 249 ON READER SERVICE CARD

THE BEST GAME

Having just finished reading your August 1987 issue reviewing IBM's new Personal System/2 line, I commend you on your usual excellent in-depth coverage. However, being inclined as you frequently are to reporting on which bit is where and making price/performance comparisons, I'm afraid you've missed the point. IBM is apparently once again the best game in town.

First, realizing that the 80386 processor is capable of power approaching that of a minicomputer and, unlike most other PC manufacturers, having some measure of experience in the minicomputer field, IBM decided, and rightly so, that a minicomputer-style architecture was in order to unlock the full power of the 80386. Further, also realizing that 80286-based systems and applications are becoming prevalent, the company incorporated the new Micro Channel architecture into its Models 50 and 60 in order to provide a clear migration path to the 80386. As for the Model 30, although a number of shortcomings are apparent, it is completely understandable that an 8086-based system, being particularly suited to stand-alone applications, did not warrant the added expense of incorporating the Micro Channel.

Secondly, as was stated in John Cockerham's article "VGA: Evolutionary Half-Step" (p. 74), the new VGA is perfectly adequate for most desktop applications. The means has been provided for an adapter board to gain control of the video subsystem (via the special video slot) to provide higher graphics capability to machines that need them. So why should we all be made to pay for this extra capability?

Third, many of the issues raised concerning disks are chronic ones in IBM products, and I agree that a more expedient approach should have been used. But, as was also pointed out, at least the company has embraced the 3.5-inch diskette as a standard and acknowledged that mass storage is now a basic requirement.

Finally, the price/performance comparisons made in the articles will, over time, become irrelevant. As new

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operating systems and applications appear that exploit the 80286 and, more importantly, the 80386, the value of this new architecture will become clear. The superiority of IBM's design will show through and the other manufacturers of 80386-based systems, such as Compaq and ALR, may find themselves standing embarrassed. As for the complaints of IBM being too conservative—this is the very essence the IBM image anyway. Besides, compatibility with present systems and applications would have been lost or they would have priced themselves right out of the market if any really radical changes in design or technology had been made. The ultimate PC was not and should not have been the goal. Long-term strategy is key and IBM has chosen a course that puts it on solid ground for the future while leaving the door open for improvement as the industry continues to develop. Overall, it seems that the new PS/2 line is a fairly well conceived and implemented step in PC evolution, and I, for one, feel that it eventually would be worth the additional cost of investment.

Fredrick L. Robinson
Rochester, NY

In the sidebar "Physical Specifications" of the Micro Channel construction article ("An Architecture Redefined," David Methvin, August 1987, p. 58), the definition of *mil* is incorrect. A mil is 0.001 inches, not 0.01 inches.

On the same page, two more reasons for the +5 volt power pins of the edge connector being shorter (if the card is inserted or removed with power on) are valid. First, when the card is inserted, the I/O pins make electrical contact with the system board first. The pins are then *referenced* prior to power being applied to the card when the power pins make contact with the system board connector. This helps prevent *latch-up* of CMOS devices. Second, when the card is removed, since the power pins are shorter, +5 volts is removed from the card first, prior to the I/O pins becoming unreferenced, again helping to prevent latch-up.

Jeff O'Neil
ARCO Oil and Gas Company
Plano, TX

Thank you for the correction on the definition of mil and for providing additional details regarding the latch-up problem of CMOS devices.

—DM

PRACTICALLY SPEAKING

Although the article "Database Design Techniques" by Dave Browning (July 1987, p. 112) was an excellent introduction to database design, I disagree with his analysis of "pure" versus "practical." "Pure" database design must take into account all of the facts about the entities that the database reflects. What "pure" database design ignores is how those facts will be accessed. Performance trade-offs are taken into account after "pure" design.

One of the facts about the order entry system being designed is that the price of an item does not change from the time of the order. This fact is reflected in the "practical" database, but is left out of the "pure" database. As a result, the "pure" database is not pure, it is simply wrong. I believe that a similar look at the Stock Number would reveal the same sort of design error in the "pure" database design. The transition from a "pure" to a "practical"

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database is in reality a transition from an incorrect to a correct database.

Although his final "practical" database is correct, it is important that designers do a complete "pure" database design, before proceeding to the "practical" database. It is also good to document the "pure" database to have a correct design as a starting point.

Robert Stockwell
Concord, CA

Mr. Stockwell's point seems to be that the normalized "pure" database design is incorrect because it does not take into account how the data is to be used. Although the "pure/practical" terminology may have seemed misleading, the notion of designing a database that is theoretically normalized and then modifying it to accommodate practical considerations is nothing more than a two-step approach to design. Many systems of all kinds are designed in steps, starting with drafts of conceptual design documents and leading through refinements until a final detailed design is produced. The fact that early versions are not the same as the final version does not make them incorrect, merely preliminary. System designers must often start with an overly simplistic design and build upon it instead of trying to incorporate all possible considerations in a single step. The point of the "pure/practical" designs in the article was made to demonstrate the fundamentals of building a database design founded on normalized tables and modified to incorporate practical considerations.

—Dave Browning

ERRATA

In the article "Detecting Display Systems" (Programming Practices, July 1987, p. 174), an error appears in listing 4, DSPYINFO.C. The logic fails to detect the presence of a Monochrome

```
if (!egaflag || (egaflag && ega_mode == 0))
    /* look for IBM monochrome memory */
    if (memchk(MDA_SEG,0))
        ++mdaflag;
if (!egaflag || (egaflag && ega_mode == 1))
    /* look for color/graphics memory */
    if (memchk(CGA_SEG,0))
        ++cgaflag;
```

Display Adapter (MDA) card only if it has found an Enhanced Graphics Adapter (EGA) in the color mode. It also should look for an MDA when no EGA card is found, and it should look for CGA memory only when no EGA is present or when an EGA is found to be in monochrome mode. In DSPYINFO.C, the lines of code that test for and report whether any monochrome and color/graphics memory is found should be changed to read as shown in the accompanying figure.

In "A Note from COMDEX," a sidebar to the August 1987 Directions column (Will Fastie, p. 9), the name of the accounting package from Q. W. Page Associates should read NewViews. *PC Tech Journal* regrets the errors.

COMMENT AT WILL

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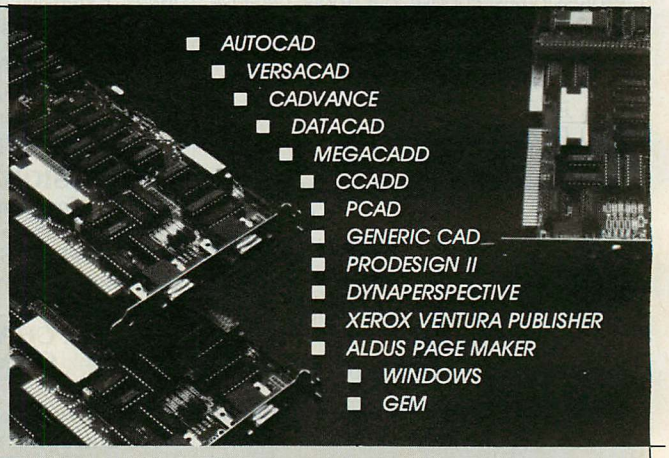
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fortran language

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wendin products

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Microport Products *See Microport Section*		
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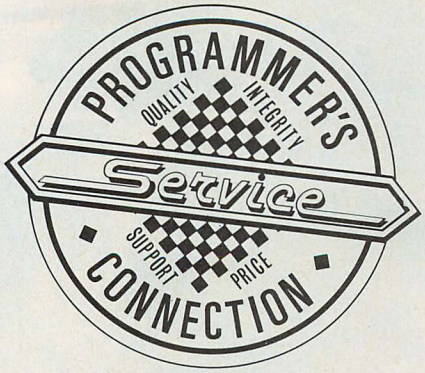
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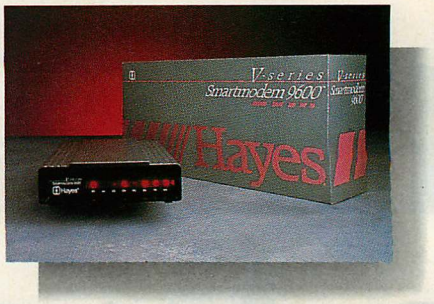


CIRCLE NO. 231 ON READER SERVICE CARD

Developments for the systems professional



Hertz AT386 Plus Model 80



Hayes announces the V-series Smartmodem 9600

SYSTEMS

The first two members of the **Wang PC 200/300 Series**, a family of personal computers from **Wang Laboratories, Inc.** has been announced. The **Professional Computer 280** and **Professional Computer 380** are based on the 80286 and 80386 respectively. The differences between the PC 280 and PC 380 lie primarily in power and performance that result from the different microprocessor. Both systems are bundled with MS-DOS 3.2 and Microsoft Windows, use the same eight-slot chassis, and come standard with a 1.2MB diskette drive, a disk controller that can support two hard-disk drives, and a multimode video controller that supports Hercules monochrome graphics and IBM CGA and EGA modes. The 80286 system can be upgraded to the 80386 system simply by replacing the system board. A PC 280 and 380 can become a full-function VS workstation via the Wang Local Office Connection. Both machines come standard with one serial port and one parallel port. PC 280 prices range from $3,850 to $4,875, PC 380 prices range from $6,495 to $8,495.
Wang Laboratories, Inc., One Industrial Avenue, Lowell, MA 01815; 800/522-9264; 617/459-5000
CIRCLE 301 ON READER SERVICE CARD

A 16-MHz microcomputer based on the Intel 80386 has been introduced by **Hertz Computer Corporation**. The **Hertz AT386 Plus Model 80** has serial and parallel ports, 195-watt power supply, eight I/O slots (two 32-bit, four 16-bit, and two 8-bit), and a socket for an 80387 or 80287. The Model 80 comes standard with 512KB base RAM, 2MB 32-bit RAM, an 80MB hard disk, choice of a 5.25-inch (1.2MB or 360KB) or a 3.5-inch (720KB) diskette drive, a 60MB tape backup, 2400-bps internal modem, EGA adapter, and operating system software. $6,995.
Hertz Computer Corporation, 325 Fifth Avenue, New York, NY 10016; 212/684-4141
CIRCLE 302 ON READER SERVICE CARD

CONNECTIONS

Hilgraeve, Inc. has released **version 3.22** of its **HyperAccess** communications program. This version offers higher data transmission speed and features emulation of the DEC VT-220 terminal with support for a wide range of VT-220 features, including ASCII, multinational, graphics, British-French-Canadian and German character sets, alternate keypad modes, 7- and 8-bit modes, auto-wrap, host-definable top and bottom margins, host-definable tabs, insert and replace mode, select graphic rendition, auto-print mode, printer-controller mode, print-cursor-line mode and

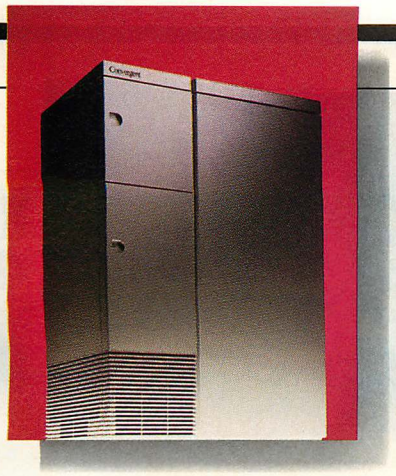


Screen shot of HyperAccess 3.2 from Hilgraeve, Inc.

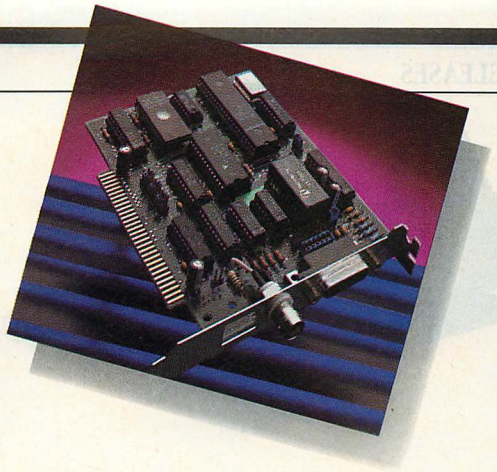
print-screen mode. Transmission rates as fast as 57,600 bps are supported. $149; upgrade to 3.22, $30.
Hilgraeve, Inc., P.O. Box 941, Monroe, MI 48161; 800/826-2760; 313/243-0576
CIRCLE 313 ON READER SERVICE CARD

Four modems that incorporate V-series system technology were introduced by **Hayes Microcomputer Products, Inc.** The **V-series Smartmodem** models—the external **9600** and **2400**, the internal **9600B** and **2400B**—are communications products that provide features (such as error control) through the implementation of the LAPB link level portion of X.25 and Asynchronous Framing Technique (AFT) allowing point-to-point error control, supports international standards, and provides a migration path to X.25 or other synchronous communications. Other features include adaptive data compression for increased throughput, and automatic feature negotiation which analyzes all options, including speed available for modem link and selects combination that maximizes data transmission efficiency. The V-Series Smartmodem 9600 and 9600B (internal) are both 9600-bps, half-duplex modems implementing V.32 Trellis Code modulation. Like the 9600-bps models, the V-series Smartmodem 2400 and 2400B are Bell 103/102 and CCITT V.22 and V.22*bis* compatible, allowing them to communicate with existing modems. V-series Smartmodem 9600, $1,299; 9600B, $1,199, (with Smartcom III, $1,299); 2400, $899; 2400B, $849, (with Smartcom III, $899).

Hayes also has released **Smartcom III**, a full-featured communications program designed to support the V-series system modems. Smartcom III has a flexible user interface that allows both menu-driven and command-level operations as well as a powerful programming language, Simple Communications Programming Environment (SCOPE). Additionally, **Smartcom II version 3.0** with V-series support has been released. Until December 31, 1987, users who surrender their original Crosstalk diskettes to Hayes can purchase Smartcom III for $60. Smartcom III, $249; upgrades from Smartcom II to Smartcom III, $30 to $75 (depending upon when Smartcom II was purchased); Smartcom II 3.0, $149.



The Server PC from Convergent Technologies



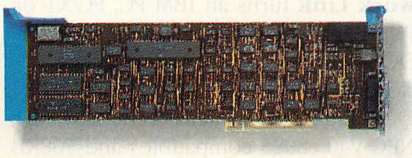
Novell Ethernet adapter card from Santa Clara Systems

The **V-Series Modem Enhancer**, a stand-alone unit that can be attached to any Hayes external modem, provides V-series system technology to current users of Hayes modems without requiring a new modem. $349.
Hayes Microcomputer Products, Inc., 705 Westech Drive, Norcross, GA 30092; 404/441-1617
CIRCLE 311 ON READER SERVICE CARD

A high-performance departmental server for networks of PCs and terminals is available from **Convergent Technologies, Inc.** Using the full capabilities of the 20-MHz Intel 80386, **The Server PC** integrates the functionality of a PC server and a UNIX multiuser system. Running CTIX/386 (Convergent's implementation of AT&T's UNIX System V release 3.0) and DOS with Locus Computing's Merge 386 software, UNIX and DOS applications can be used simultaneously in a integrated environment. PC Exchange/VINES networking software allows the Server PC to support networks of PCs and terminals. Up to 64 PCs and terminals are supported. The Server PC uses an integral 64KB write-back cache with zero wait states and supports full 32-bit data paths for maximum performance.

The SCSI disk controller provides throughput with data rates up to 5MB per second. Optional math coprocessors—the Intel 80387 and the Weitek 1167—are available to further enhance computational ability. Base configuration includes 4MB of memory, an 80MB or 145MB disk drive, a 1.2MB diskette drive and three full-height bays for additional SCSI peripherals. Memory is expandable to 64MB and disk storage to 1GB. Ten expansion slots can accommodate PC and AT slots as well as 32-bit peripherals and can support several intelligent eight-port serial communications processor cards. The AT-bus architecture allows the addition of standard networking cards, including Ethernet and Token Ring. Prices start at $7,500 in OEM quantities.
Convergent Technologies, Inc., 2700 N. First Street, San Jose, CA 95150-6685; 408/434-2848
CIRCLE 308 ON READER SERVICE CARD

A 5251 emulation board connecting IBM Personal System/2 Models 50 and 60 with IBM System 34/36/38 minicomputers has been introduced by **IDEAssociates, Inc.** The **IDEAcomm 5251/MC** uses a twin-axial cable to connect Micro Channel PS/2s to the System/3x or to remote controllers (5294 or 5251 model 12). This product enables PCs to emulate IBM 3180, 5251 model 11, 5291, and 5292 model 2 terminals and can be used with either a color or



IDEAssociates' IDEAcomm 5251/MC

monochrome monitor. The product supports up to four concurrent host sessions, which can be viewed simultaneously using a windowing feature. A hot key allows users to toggle between host and DOS sessions. $895.
IDEAssociates, Inc., 29 Dunham Road, Billerica, MA 01821; 617/663-6878
CIRCLE 312 ON READER SERVICE CARD

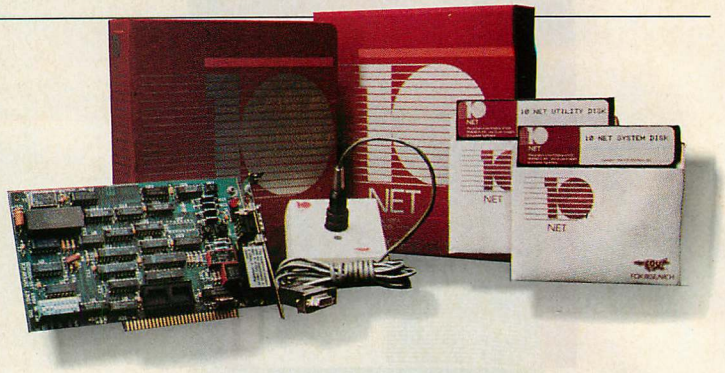
Containing the latest CMOS technology, the **Ethernet adapter card** is being shipped by **Santa Clara Systems**, a wholly owned subsidiary of Novell, Inc., The incorporation of the DP8390/91/92 chip set allows the Ethernet card to run cool and consume less power. The Ethernet adapter fully supports the IEEE/ANSI 802.3 Ethernet LAN standards and supports thick and thin Ethernet coaxial cabling, with an on-board transceiver for thin Ethernet connections. The initial version of the Ethernet adapter card (being marketed under the Novell label) supports Novell's NetWare operating system. $395.
Santa Clara Systems, 1610 Berryessa Road, San Jose, CA 95133; 408/729-6700
CIRCLE 309 ON READER SERVICE CARD

A strategic partnership formed by **Microsoft Corporation** and **3Com Corporation** has 3Com codeveloping and jointly marketing **Microsoft OS/2 LAN Manager**. Announced in April 1987, the product is an advanced LAN operating environment that provides support for a new generation of distributed applications. Areas that 3Com will be contributing include protocol support, performance enhancements, popular networking card compatibility and additional network functionality.
Microsoft Corporation, 16011 N.E. 36th Way, P.O. Box 97017, Redmond, WA 98073-9717; 800/426-9400; 206-882-8088
CIRCLE 303 ON READER SERVICE CARD
3Com Corporation, 3165 Kifer Road, Santa Clara, CA 95052-8145; 408/562-6400
CIRCLE 304 ON READER SERVICE CARD

Soft-Switch, Inc. and **3Com Corporation** have announced **SNADS Gateway/3+Mail**, a software gateway that allows electronic mail to be sent between 3Com's 3Systems and IBM mainframes using IBM's Systems Network Architecture Distribution Services (SNADS). The Gateway/3+Mail communicates directly with Soft-Switch's SNADS Gateway/MVS or IBM Distributed Office Support System (DISOSS) product on an IBM MVS host computer. This allows 3+Mail users to exchange mail transparently with a variety of mainframe host electronic mail systems. SNADS, part of IBM's Systems Application Architecture (SAA), defines the protocol for communication between mail servers in an SNA network. SNADS



OPUS PCT4 from Esprit Systems



Fox Research's 10-Net LAN

Gateway/3+Mail running on an AT or compatible, uses a SNA LU6.2 session to connect to the SNADS-based network. Gateway license is between $3,000 and $5,000.
Soft-Switch, Inc., 955 Chesterbrook Blvd., Wayne, PA 19087-9953; 215/640-9600
CIRCLE 305 ON READER SERVICE CARD
3Com Corporation, 3165 Kifer Road, Santa Clara, CA 95052-8145; 408/562-6400
CIRCLE 306 ON READER SERVICE CARD

A PC-Term compatible for DOS- and XENIX-based multiuser systems has been introduced by **Esprit Systems, Inc.** Featuring remote dial-in and a full range of ASCII emulations, the **OPUS PCT4** allows users to access applications running on the IBM PC, PC/XT, PC/AT and 80386 computers. The keyboard and video display completely emulate the IBM PC user interface; in PC-Term mode, OPUS PCT4 duplicates the complete IBM 256 character font set, keyboard layout, and PC scan codes and uses the standard 25-line PC display. The OPUS PCT4 supports up to four pages in memory and allows writing to the undisplayed page. Dual-port technology allows concurrent connection through two ports; any two emulations can be selected to operate as two independent virtual terminals that can be selected with a hot key. Backed by Esprit Express 24-hour replacement service, OPUS PCT4 is available with 14-inch flat screen in amber, green, or paper white. $649.
Esprit Systems, Inc., 100 Marcus Drive, Melville, NY 11747; 800/645-4508; 516/293-5600
CIRCLE 314 ON READER SERVICE CARD

A major release of **Fox Research**'s 10-NET LAN, **10-NET NETBIOS** has been announced. This release uses SMB protocols and interfaces to Fox's NETBIOS and OSDI transport software for communications. Additional features include windowing for the CHAT feature and systems monitor feature. All bundled utilities available in 10-NET are included, such as menu-driven security, network management tools, news calendar, spooling, remote job submission. The 10-NET NETBIOS software comes bundled with the 10-NET StarLAN board (which meets the specifications of the IEEE 802.5 1BASE5 committee), tap box, and cable. $695.
Fox Research, Inc., 7016 Corporate Way, Dayton, OH 45459; 800/358-1010; 800/782-1010
CIRCLE 310 ON READER SERVICE CARD

A combination hardware and software system, the **QuickLink** from **The Network Link** turns an IBM PC, PC/XT or PC/AT into a multiuser, multiprocessor DOS computer system running the Novell NetWare operating system. The QuickLink card contains a 16-bit, 8-MHz NEC V40 (8086 compatible) and 768KB of RAM (640KB user memory). Up to 16MB of cache memory can be added to the central PC file server. A standard ASCII terminal connects to the card using telephone wiring. For each card and terminal connected, a complete DOS workstation is added to the multiuser system. $1,095.
The Network Link, 3303 Harbor Blvd., Building H-10, Costa Mesa, CA 92626; 714/549-9380
CIRCLE 315 ON READER SERVICE CARD

Additions to **ProNET-10**, a 10 Megabit-per-second (Mbps) token-ring network, have been made by **Proteon, Inc.** An interface for the IBM Personal System/2 Micro Channel and an advanced network management software package, called **TokenVIEW-10**, are two of the additions. The Micro Channel high-speed interface provides a direct connection for IBM's PS/2 Models 50, 60, and 80. This connection fully exploits the high-capacity memory and Micro Channel architecture. ProNET-10 offers the PS/2 family multivendor and multinetwork connectivity options with interfaces to Digital Equipment Corporation's UNIBUS and Q-bus systems, the Intel MULTIBUS- and VMEbus-based computers, and the IBM PC, PC/XT, and PC/AT. Proteon's Gateway allows users on ProNET-10 to communicate with users of Proteon's 4 Mbps ProNET-4, which complies with the IEEE 802.5 standard and interoperates with IBM's Token-Ring Network. IBM PS/2 users can choose among several software environments such as TCP/IP, Novell's NetWare, and Banyan VINES. Proteon's ProNET-10 supports the IBM Cabling System, fiber-optic cables, microwave and infrared signals, and broadband transmission rates. ProNET-10 p1300 PC interface card, $545; p1303 PC/AT interface card, $595; price for TokenVIEW-10 is not yet available.
Proteon, Inc., Two Technology Drive, Westborough, MA 01581-5008; 617/898-2800
CIRCLE 307 ON READER SERVICE CARD

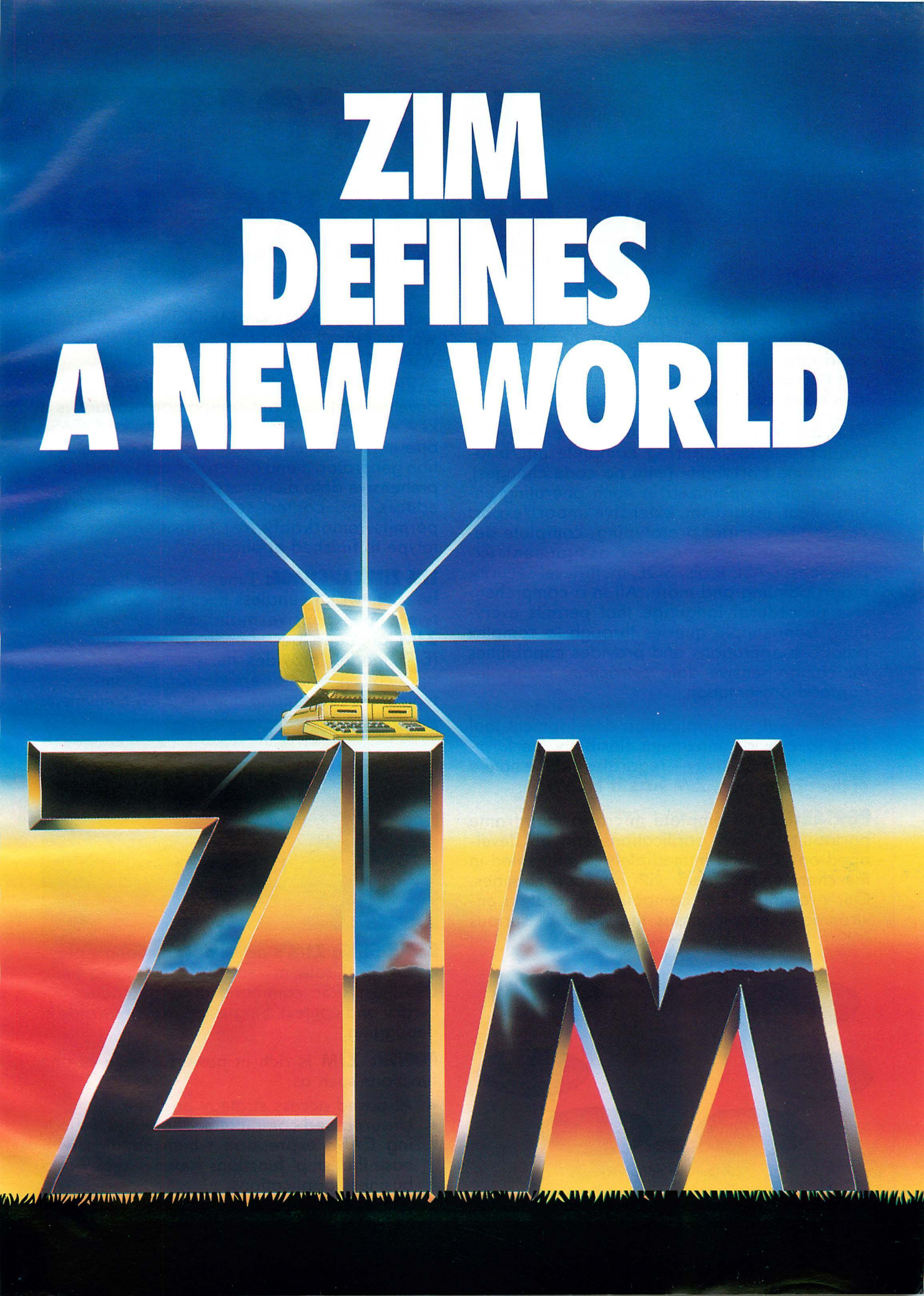
PERIPHERALS

A **monitor cable** that is able to connect third-party monitors to the IBM Personal System/2 has been announced by **Cables To Go**. The cable is designed to work with multiscanning monitors from Sony, NEC, Thompson, Teknika, and others. $49.95; in OEM quantities of 25 or more, $18.95 each.
Cables To Go, 26 W. Nottingham Road, Suite 200, Dayton, OH 45405; 800/826-7904; 800/826-0958
CIRCLE 321 ON READER SERVICE CARD

From **Flagstaff Engineering, Inc.** comes the **EDAPT** (external diskette adapter), a drive-interface package that allows an IBM Personal System/2 to access 3.5-, 5.25-, or 8-inch diskettes on existing drives. The interface package

Continued on p. 37

ZIM DEFINES A NEW WORLD



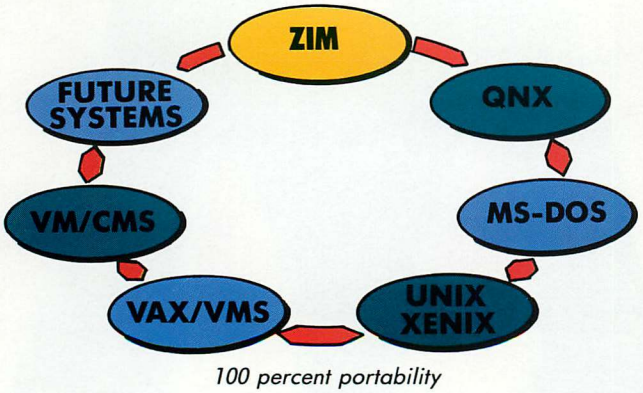
WELCOME TO OF SERIOUS 4GL/

ZIM, the Fourth-Generation Language/Database Management System that has set new standards in Power, Performance, Productivity and Portability welcomes you to the **ZIM** world of serious application development.

ZIM 3.0 is the most comprehensive 4GL tool available today, offering complete micro-to-mainframe portability (with no code changes), *performance optimized* in each operating environment, multi-user, extensive import/export capabilities, rapid prototyping, complete debugging facilities, nested assignment expressions, CASE tools, SQL, multi-level security, report painting and more. All in a comprehensive procedural language that permits everything from simple queries through to complex database operations and provides capabilities for comprehensive data extraction, manipulation and presentation.

To be useful, an application development tool **has** to provide maximum flexibility, performance and productivity—regardless of the nature of the application. ZIM **has it** NOW!

PORTABILITY: Complete micro-to-mainframe portability means applications can be developed on PC's and immediately implemented in the client environment with no code changes. Our growing list of compatible operating environments encompasses the world of serious technology: single user MS-DOS, MS-DOS networks, Novell networks, QNX, UNIX, XENIX, VAX/VMS and VM/CMS.



100 percent portability

DEVELOPMENT ASSISTANT: ZIM/DA (ZIM's development assistant companion product) is a key element in **ZIM's** productivity and CASE offerings. **ZIM/DA** is comprised of an application generator, menu generator, active and comprehensive data dictionary, report painter, code editors and context-sensitive help. **ZIM/DA** permits remarkably fast transition from prototype to finished application.

THE ZIM LANGUAGE: Time is money. It shouldn't be spent writing endless lines of code or worse, tying up expensive mainframe systems. The **ZIM** language, based on the entity-relationship (E-R) model, provides the power that serious application developers demand. Compare a typical SQL command and the **ZIM** equivalent:

SQL:

```
SELECT *
FROM WORKONTAB, PROJECTS, EMPLOYEES-
WHERE WORKONTAB.ENUM = EMPLOYEES.ENUM-
AND WORKONTAB.PNUM = PROJECTS.PNUM-
AND PROJNAME = 'ALPHA'
```

ZIM:

```
LIST ALL EMPLOYEES WORKON PROJECTS WHERE
PROJNAME = 'ALPHA'
```

DEBUGGING: ZIM's active data dictionary plays an integral role in reducing debugging time. Use the PARSE command to verify coding accuracy and context. Singlestep execution aids in debugging.

POWER: ZIM is rich in powerful features and functions such as:

- AI-based access strategy analyser.
- Unsurpassed computational abilities, including CASE expression which handles with ease the 'step' functions found in real-world business applications.

THE WORLD DBMS PROGRAMMING

- Natural multi-user features including user-defined transactions, roll-back, audit trails and roll-forward.
- Complete code-data independence.
- Exceptional text-handling capabilities.
- Unlimited forms manipulation and report-writing capabilities.
- Multi-lingual applications (French, German etc.)

SECURITY: ZIM's multi-level security features include log-in, passwords, permission-based access to entity sets, relationships and fields and encryption/decryption of entity sets and relationships.

VIRTUAL FIELDS: ZIM's unique virtual fields capability allows you to easily implement composite or concatenated keys, derived or computed fields, soundex indexes, etc.

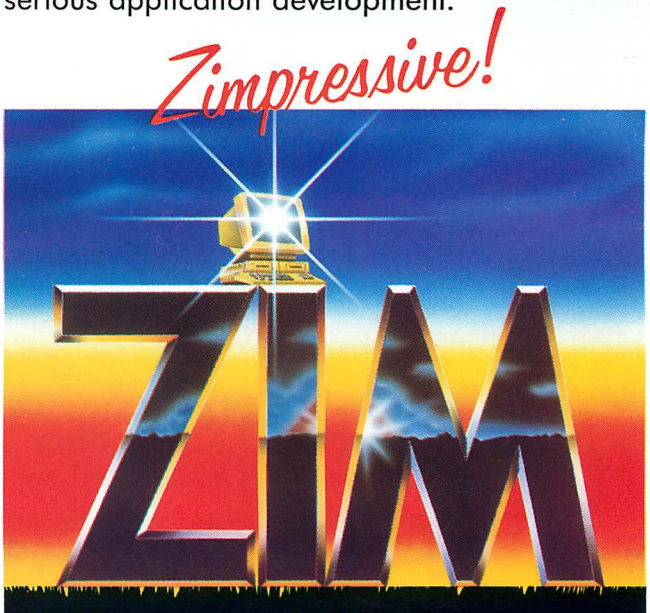
IMPORT/EXPORT: ZIM masters the importing and exporting of screens and data to and from word-processing, spreadsheets and provides superlative forms composition through laser printers. **ZIM** applications already in use have saved millions of dollars through the reduction and/or elimination of paper forms.

ZIM is supported by an ever-growing family of companion products like **Niva's Guide to ZIM** (the authoritative guide from introductory to expert levels), the **ZIM Compiler** to ensure the highest level of performance of your **ZIM** application, a **Program Language Interface** permits "C" access to **ZIM** databases, **ZIM-ISQL** allows queries based on SQL syntax, **Runtime** and **Query Runtime** systems and **ZIMPLE,** an add-on module that permits easy use, allows end-users to create their own simple applications, ad hoc queries or paint their own reports (used with **ZIM** or **Query Runtime**).

And you'll be supported too! Zanthe's Priority Support program includes first-rate telephone technical support, free updates, new versions and periodic technical bulletins. **Code Review** and **Training** services are available for all levels of **ZIM** users.

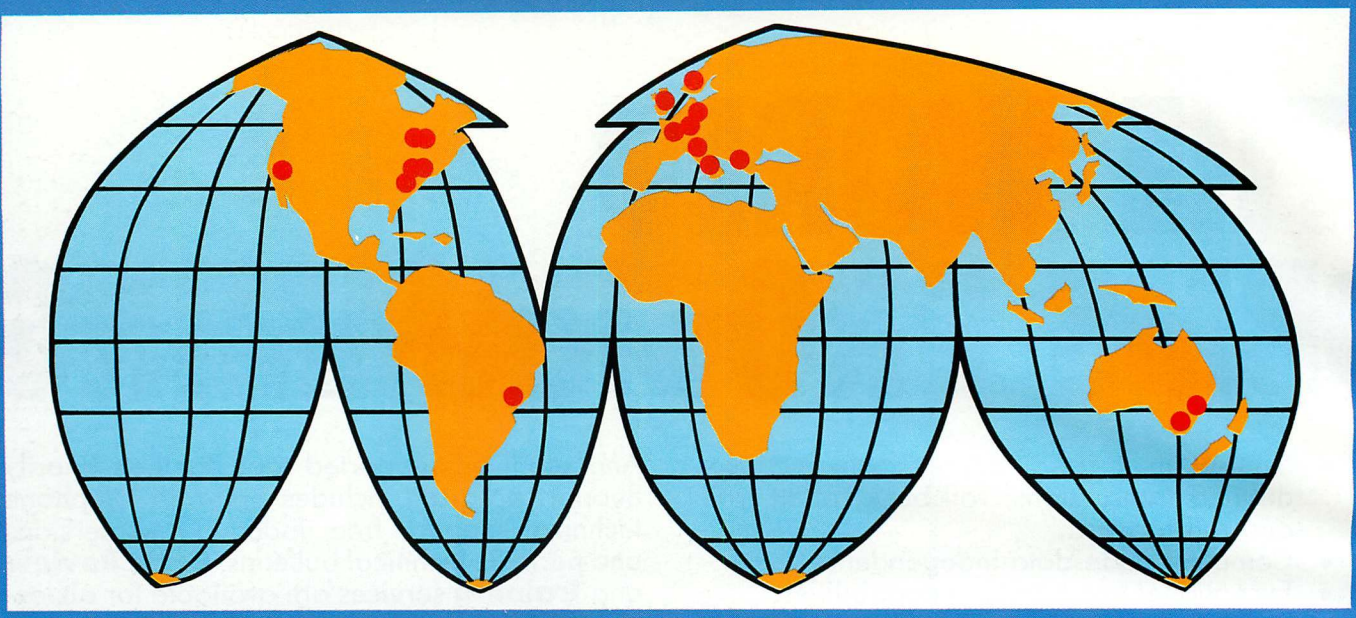
Around the world, from Australia to Europe, **ZIM Service Centers** and **Distributors** stand ready to supply and assist any **ZIM** user.

Already an integral part of data management in national governments, international banks, financial corporations and thousands of other applications **ZIM** welcomes you to the world of serious application development.



Zanthe Information, Inc.
1200-38 Antares Drive
Nepean, Ontario K2E 7V2
U.S. 800-267-9972
Canada 613-727-1397

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ZIM DEFINES WORLD CLASS

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91201
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Mr. John Nessen
818-241-0619

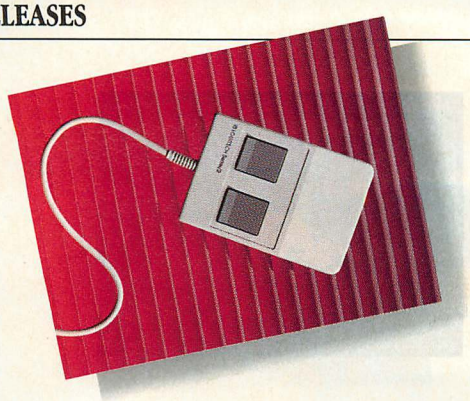
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Edison, NJ
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U.S.A.
Mr. Fred Pack
201-985-8000

Lamda Micro Systems Inc.
111 John Street
New York, NY
10038
U.S.A.
Mr. Dean Kyriakos
212-349-2432

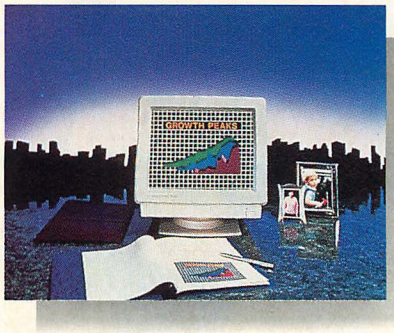
Systems Marketing Group
5433 Tree Line Drive
Centerville, VA
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Mr. Larry Olson
703-631-5083

ZANTHE INFORMATION, INC.

1200-38 Antares Drive, Nepean, Ontario K2E 7V2
U.S. 800-267-9972 Canada 613-727-1397



PS/2-compatible Series/2 mouse from LOGITECH



Multisync Plus color monitor from NEC

consists of one 2-inch by 2-inch connector installed in the second drive assembly of the PS/2. A flat cable, which connects to the card, runs down through the PS/2 and connects to an existing drive and a power cable with uses the PS/2 +5 and +12 power supply. The data rates that the EDAPT delivers are 250 or 500 bps. $99.
Flagstaff Engineering, Inc., 1120 Kaibab Lane, Flagstaff, AZ 86001; 602/779-3341
CIRCLE 316 ON READER SERVICE CARD

A mouse for use with the IBM Personal System/2 is being manufactured by **LOGITECH, Inc.** The **LOGITECH Series/2 Mouse** plugs directly into the PS/2 mouse port and is both hardware and software compatible with the PS/2. LOGITECH's **Plus Package** included with the Series/2 Mouse provides drivers, a pop-up menu building system, an automatic mouse configurator, a special interface for Lotus 1-2-3, and a powerful mouse-based text editor. LOGITECH also announced an upgrade to the driver for its Serial Mouse to make it compatible with the PS/2. Series/2 Mouse, $99.
LOGITECH, Inc., 6505 Kaiser Drive, Fremont, CA 94555; 800/231-7717; 800/552-8885
CIRCLE 320 ON READER SERVICE CARD

A graphics card for the IBM Personal System/2 models 50, 60, and 80 has been developed by **Hercules Computer Technology**. The **Hercules PS/2 Card** will add Hercules 720-by-348 graphics compatibility and RamFont capability without interfering with the graphics included on the motherboard. The PS/2 Card will drive either analog color or monochrome monitors through the PS/2's built-in Video Graphics Array (VGA). $299.
Hercules Computer Technology, 2550 Ninth Street, Berkeley, CA 94710; 415/540-6000
CIRCLE 322 ON READER SERVICE CARD

Four products that transport data between the IBM PC and Personal System/2 environments has been introduced **Sysgen, Inc.**. The **3.5-inch Bridge-File** provides a two-way link between the two IBM families, with both 720KB and 1.44MB diskette storage. The **5.25-inch Bridge-File** provides 360KB and 1.2MB of diskette storage. The **Bridge-Tape** provides a tape-unit capacity of 42MB to port data to the PC and the PS/2. Adapter cards for both the PC and PS/2 families enable these bridges to exchange data between the two systems. Sysgen's 15MB removable hard-disk subsystem, the **External DuraPak**, now can tie into both the PC and the PS/2 Model 30. Bridge-File (either size), $325; Bridge-Tape, $795; DuraPak, $1,595.



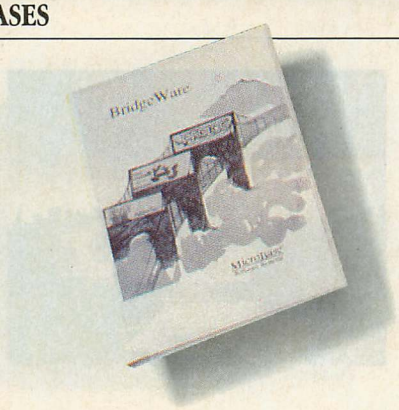
Sysgen's Bridge-File 5.25-inch external disk drive

Sysgen, Inc., 556 Gibraltar Drive, Milpitas, CA 95035; 408/263-4411
CIRCLE 324 ON READER SERVICE CARD

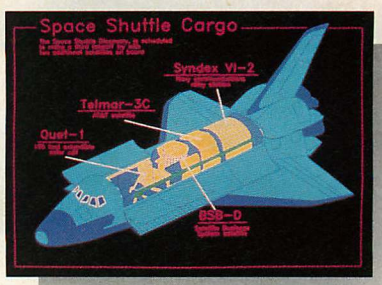
A high-resolution, multiscanning color monitor is being offered by **NEC Home Electronics, Inc.** Resolution in the **Multisync Plus** has been increased to 960-by-720 pixels. A three-way switch for text modes turns the Multisync Plus into a monochrome monitor with white, green, or amber screens. Automatic synchronization of horizontal- and vertical-scan rates are possible from 21.8 to 45 MHz horizontally and from 50 to 80 Hz vertically. The Multisync Plus has the ability to display up to 64 colors while running with a TTL (transistor-to-transistor logic) signal used by the IBM EGA and unlimited colors with an analog signal used by the IBM Professional Graphics Controller (PGC), Video Graphics Array (VGA), and Multi-Color Graphics Array (MCGA) boards. A flattened, 15-inch square cornered screen with a 14-inch display area offers a reduction in reflected glare and increase in total viewing area. Users have a choice of two video input connectors, a standard 9-pin D-Sub, and high-performance BNC connectors. An optional adapter for TTL boards is available. $1,399.
NEC Home Electronics (U.S.A.), Inc., 1255 Michael Drive, Wood Dale, IL 60191; 800/632-7638; 312/860-9500 extension 4244
CIRCLE 319 ON READER SERVICE CARD

Designed for use with the IBM Personal System/2 Model 50, 60 and 80, a **1.2MB External 5.25-inch Floppy Disk Drive** is available from the **Nth Group**. This diskette drive transfers data from 5.25- to 3.5-inch media and vice versa. For the users whose databases are on the standard 360KB 5.25-inch diskettes Nth Group also features a **360KB External 5.25-inch Floppy Disk Drive** for PS/2 Models 30, 50, 60, and 80. 1.2MB, $395; 360KB, $349.
Nth Group, 8100 Remmet Avenue, Unit 10, Canoga Park, CA 91304; 818/883-5506
CIRCLE 317 ON READER SERVICE CARD

A replacement motherboard for the IBM PC and PC/XT is available from **Hauppauge Computer Works, Inc.** The **Hauppauge 386 MotherBoard**, with its AT-compatible BIOS, offers advantages over add-in boards and accelerator cards because it will run the next generation of operating systems and software requiring 100-percent AT compatibility and can accept 16-bit peripherals. The 386 MotherBoard comes with a 32-bit RAM expansion connector,



Bridgeware from MicroBase Software Systems

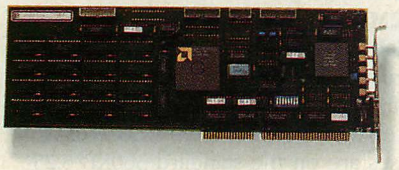


Screen produced with GSS PS/2 Device Drivers

allows up to 12MB of 32-bit memory to be added. $1,495; 80387, $695.
Hauppauge Computer Works, Inc., 358 Veterans Memorial Highway, Commack, NY 11725; 800/443-6284; 516/360-3827

CIRCLE 323 ON READER SERVICE CARD

An advanced graphics controller card from **Kontron Electronics** has been released. Each **7000CB graphics controller card** contains the AMD 95C60 quad-pixel dataflow manager (QPDM), a graphics processor that has four internal pixel planes. This graphics engine allows each pixel plane (1,280-by-1,280 resolution) to be connected within the processor via its own private 16-bit address bus. All data for each plane is accessed in parallel so the 7000CB maintains the same draw times, no matter how many planes are addressed. Typical draw times for the 7000CB is 100,000 vectors per second, bit-block transfers are at the rate of 18.2 million pixels per second. Line draws are done in excess of 3 million pixels per second, polygon fills are done at 12.5 million pixels per second. The 7000CB can draw 45,000 characters per second. The standard version has a single QPDM on board; a second has two QPDMs on board. Either version allows displayable resolution of 1,280-by-1,024 or 1,024-by-780 pixels. The standard color palette allows 16 colors out of 4,096. Prices start at $2,995.
Kontron Electronics, 630 Clyde Avenue, Mountain View, CA 94039-7230; 800/227-8834



Kontron Electronics 7000CB graphics controller

CIRCLE 325 ON READER SERVICE CARD

SOFTWARE DEVELOPMENT

Developed by **A.I. Architects, Inc.**, both **OS/286** and **OS/386** are protected-mode extensions to DOS that break the 640KB barrier for PC/AT compatibles and enable 32-bit performance on 80386-based machines. OS/286 and OS/386 work with DOS so developers can keep most of their existing code. Memory constraints are effectively eliminated and programs can directly address all the extended memory installed up to 15MB (286) or 4GB (386). More terminate-and-stay-resident programs can coexist with a large application running in protected mode. Performance in 80386 systems is more than doubled in moving from 16-bit to 32-bit mode. Basic developer's kit, $495; 32-bit compilers, $895; runtime licenses for OS/286 and OS/386 are available for a nominal fee.
A.I. Architects, Inc., One Kendall Square, Cambridge, MA 02139; 617/577-8052

CIRCLE 326 ON READER SERVICE CARD

Shipment of **PS/2 device drivers** from **Graphic Software Systems, Inc.** (GSS) has begun. These device drivers enable users of GSS*CGI-based applications, such as Microrim's R:base Graphics, CADAM's MicroCADAM, Oracle's Easy SQL, to exploit the IBM Personal System/2's range of colors and display resolutions without any software modification. Programmers using either the IBM or GSS Graphics Development Toolkit can add PS/2 drivers to existing and future applications.

The **GSS Graphics Development Toolkit** for DOS application programmers includes the latest version of the GSS*CGI executive, raster font support for displays and printers, language bindings to C, BASIC, FORTRAN, Pascal, and Macro Assembler, demonstration programs, a computer graphics metafile (CGM) generator, and the PS/2 device drivers. $495; PS/2 device-driver update, $50 or $100 (depending on version).

The **GSS Device Driver volume 16** for application end-users includes a menu-driven installation utility, the updated GSS*CGI executive, and drivers for Video Graphics Array (VGA) 640-by-480 16-color, VGA/Multi-Color Graphics Array (MCGA) 640-by-480 2-color, and VGA/MCGA 320-by-200 256-color display modes. $50.
Graphic Software Systems, Inc., 9590 S.W. Gemini Drive, Beaverton, OR 97005; 503/641-2200

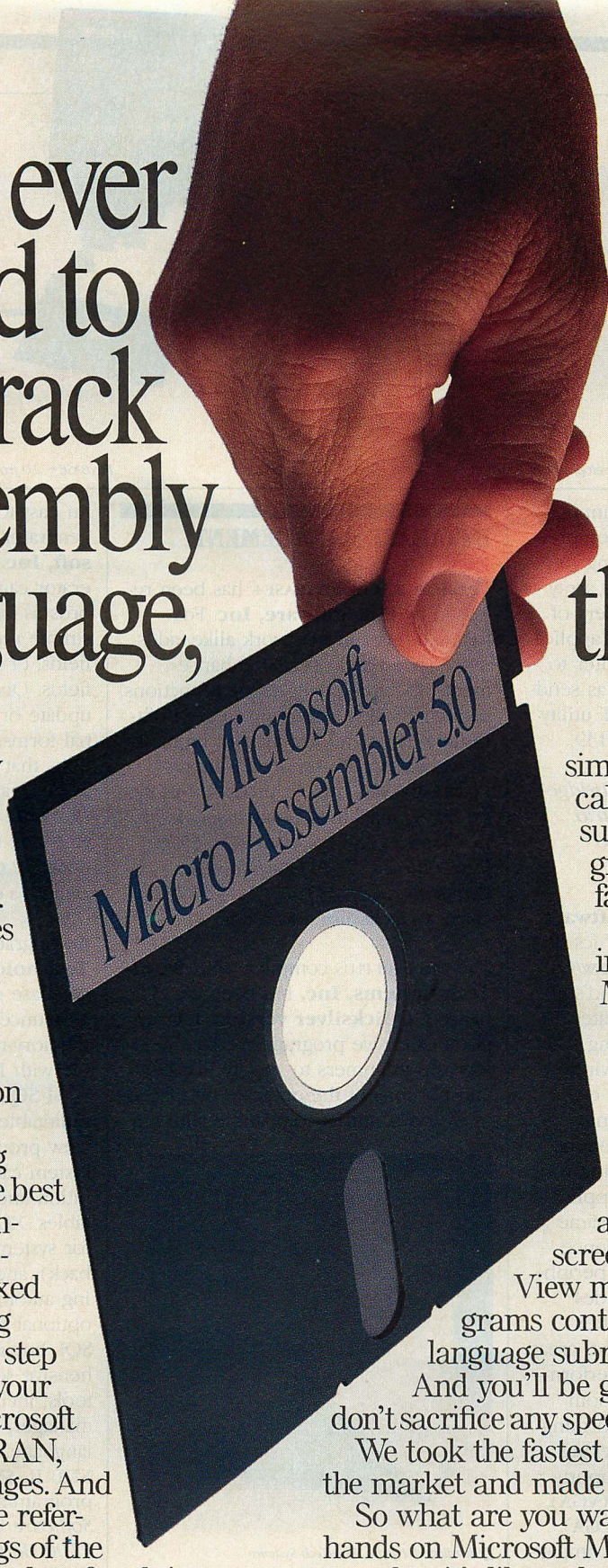
CIRCLE 327 ON READER SERVICE CARD

The release of **BridgeWare,** a knowledge base manager for Prolog applications, has been announced by **MicroBase Software Systems, Inc.** BridgeWare operates as a stand-alone application to create Prolog databases that can be used as knowledge bases in expert systems as well as other intelligent systems. The program works with plain ASCII files and can access data from virtually any package or language including dBASE, Lotus, BASIC, Pascal, C and mainframe databases. BridgeWare has the ability to combine information from several applications into a single knowledge base. $69.95
MicroBase Software Systems, Inc., Medford Office Center, P.O. Box 550, Medford, NJ 08055; 800/257-5858 extension 2940; 800/412-2340

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Version 2.2 of the **MKS Toolkit** is available from **Mortice Kern Systems, Inc.** The MKS Toolkit, a package of more than 110 software tools, enables the user to optimize the DOS environment with the power and modularity of UNIX. Some features include VI/EX, a full-screen UNIX editor; an implementation of the UNIX System V Korn shell; an AWK command, which is used in manipulating and retrieving data with a

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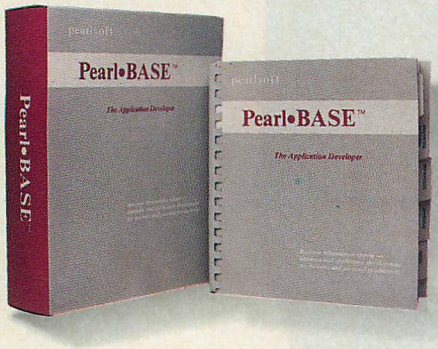
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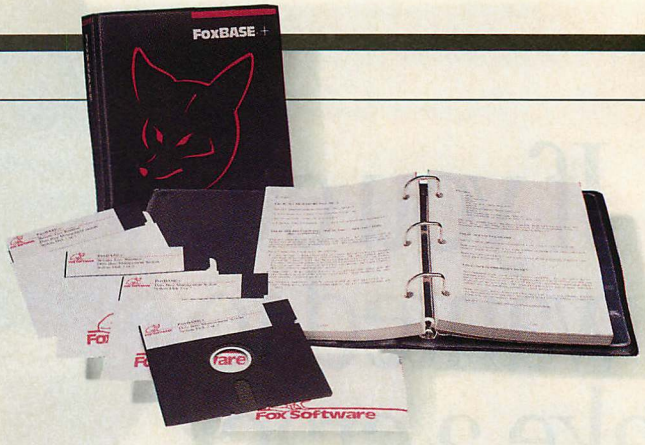
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Pearl-BASE, the application developer from Pearlsoft



FoxBASE+ 2.0 from Fox Software

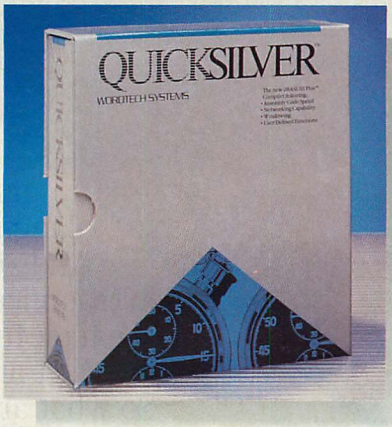
minimal amount of command input; the ability to do serious data compression on UNIX or DOS files using the Huffman encoding standard; an array of utilities to facilitate multiple users of the same machine, or multiple application environments; a flexible filter to format files for such purposes as sending to a printer; and the CRYPT utility that provides file encryption. $139; update to 2.2, $45.
Mortice Kern Systems, Inc., 43 Bridgeport Road East, Waterloo, Ontario, Canada, N2J 2J4; 519/884-2251
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Shipment of **Metagraphics Software Corporation**'s enhanced graphics development toolkit, **TurboWINDOW/C**, has begun. For use with Borland's Turbo C, the package incorporates an expanded set of graphic drawing routines, plus the added graphic windowing functions and performance enhancements required for designing multiwindowed desktop applications. With over 200 graphic/windowing routines, TurboWINDOW/C speeds application development while at the same time provides device independence over a broad range of graphic peripherals. The graphic system includes functions for dragging and rubberbanding graphic images and text, creating off-screen virtual images, performing high-speed bit-block and zoom-block image transfers and performing event-driven, mouse/cursor tracking operations. TurboWINDOW/C supports the IBM Video Graphics Array (VGA), Multi-Color Graphics Array (MCGA), and enhanced third-party EGA-compatible adapters, such as Video Seven's Vega Deluxe and Tseng Labs EVA/480. No special licensing for OEM use is required. $95.
Metagraphics Software Corporation, P.O. Box 66779, Scotts Valley, CA 95066; 800/332-1550; 408/438-1550
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DATABASE MANAGEMENT

Version 2.0 of **FoxBASE+** has been released by **Fox Software, Inc**. FoxBASE+, a dBASE III PLUS work alike, adds more speed and over 30 enhancements, including user-defined functions, saving/restoring screen images, a built-in light-bar menu facility, and immediate validation of user screen inputs. **FoxBASE+/386** runs in protected mode on 80386 machines. Single-user, $395; multiuser, $595; FoxBASE+/386, $595.
Fox Software, 27493 Holiday Lane, Perrysburg, OH 43551; 419/874-162
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The dBASE III PLUS compiler from **WordTech Systems, Inc.** has been enhanced. **Quicksilver version 1.1** supports extensive program overlays, allows programmers to specify that certain portions of the program be placed in overlays, and is compatible with any



Quicksilver 1.1 from WordTech Systems

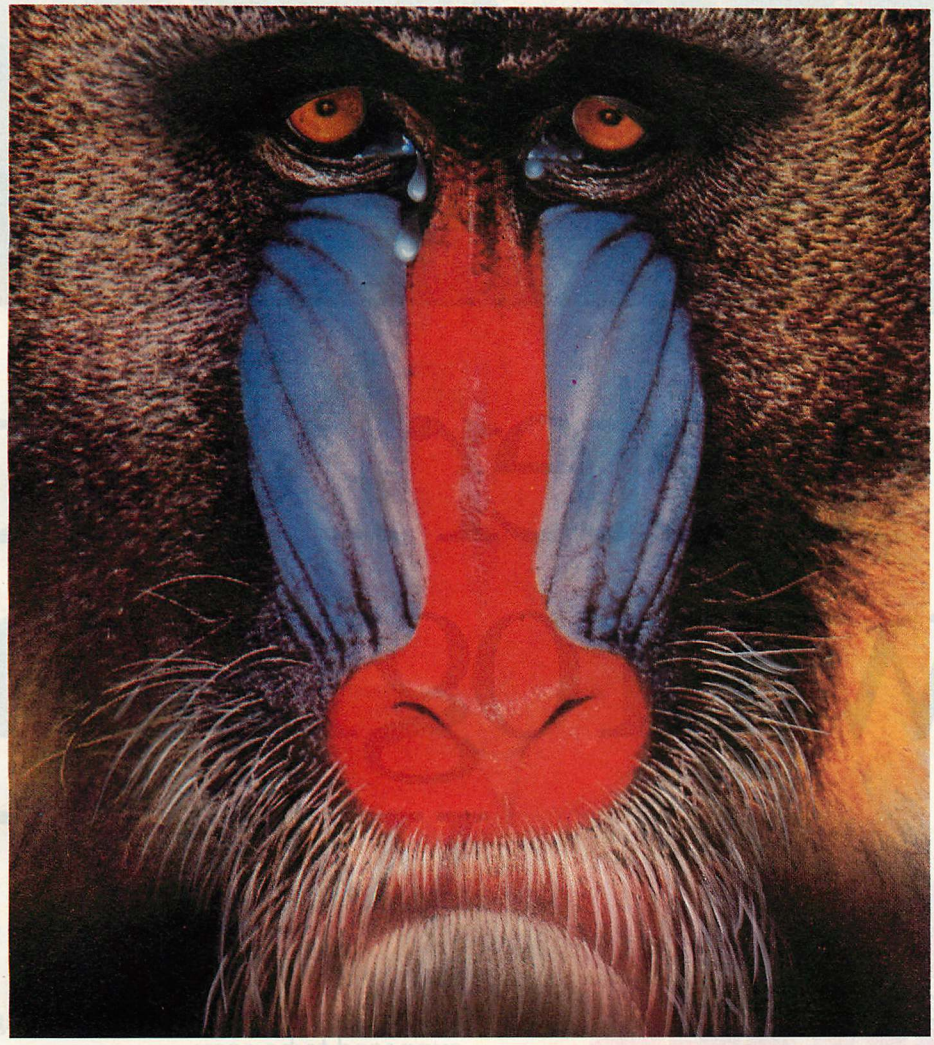
version of Plink86, a overlay linker. A VALID keywork facilitating automatic data entry validation is available. $599; upgrade to 1.1, $25.
WordTech Systems, Inc., P.O. Box 1747, Orinda, CA 94563; 415/254-0900
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An easy-to-use database and application generator has been released by **Pearlsoft, Inc.** Called **Pearl-BASE**, this generator can accommodate individual records as large as nine screen pages. A simple record may have up to 400 fields, of which 250 may be active data fields. One record can automatically update or receive data from ten external forms. The program creates applications that can remain resident in RAM while exiting to DOS. $395.
Pearlsoft, Inc., 25195 S.W. Parkway, P.O. Box 638, Wilsonville, OR 97070; 800/652-0600; 503/682-3636
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An upgrade to XDB, **Software Systems Technology, Inc.**'s SQL relational database management system, has been announced. **XDB II** incorporates a memory-resident SQL engine compatible with IBM's mainframe DB2 and ANSI SQL. A resident engine supports multitable joins, nested subqueries, view processing, data security, and a system catalog that stores all data definition and control information in SQL tables. XDB II offers multiuser features for system recovery (commit and rollback), and concurrency control, including automatic record-level locking and optional table locking. In addition to its SQL Engine, XDB II offers a comprehensive set of application generation tools, including a report writer, forms manager, menu generator, procedural language, and import/export utilities. XDB II, $395; forms manager, $295; C programming interface, $295.
Software Systems Technology, Inc., 7100 Baltimore Avenue, Suite 204, College Park, MD 20740; 301/779-5486
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Why is this guy so sad?

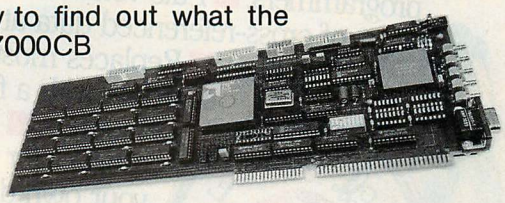


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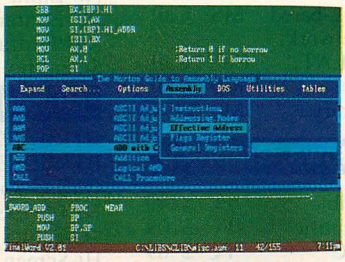
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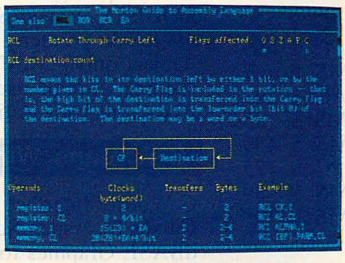
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CTree by Faircom - no royalties	MS	$315
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TECH NOTEBOOK 81

TED MIRECKI

DOS Memory Control

More pieces of the memory-management puzzle are discovered for this undocumented DOS feature.

The details of DOS memory management, introduced in DOS version 2.0, remain officially undocumented. *PC Tech Journal* published information about this back in the days of DOS version 2.1 (see "Managing Memory," William Redmond, August 1984, p. 42). With the recent release of DOS 3.3, it is prudent to review DOS memory management, generalize the previously published information to later versions of DOS, and fill-in some details of memory usage.

The memory above the resident portion of the operating system is divided into blocks, each beginning on a paragraph boundary (an address that is a multiple of 16). Each process "owns" one or more blocks. Each block of memory is preceded by a 16-byte *memory-control record* that identifies the size and owner of the block. The layout of a memory-control record is shown in the table below.

If the location of one memory-control record is known, the next one can be found as follows. Add 1 to the segment address of the record to obtain the segment address of the beginning of its memory block. To this address, add the length value from word three of the control record. The result is the segment address of the next memory-control record (not the next memory block). If this calculation is performed for the last memory block (identified with a *Z* in the first byte of its control record), the result is the number of paragraphs of memory available to DOS. For example, in a system with 640KB of memory, adding the size of the last block to its starting address results in the value A000H, which is the address of the top of memory.

DOS performs its memory-management functions by following the chain of memory-control records, creating new ones or modifying existing ones. This chain is a singly linked list—it can be followed forward to its end but not backward to its beginning. To find the beginning, DOS has a pointer to the start of the chain. The pointer is kept within the main DOS program, IBMDOS.COM, at an offset that depends on the version number. The double word at this offset, in the segment of IBMDOS.COM, is a far pointer to the first memory-control record. The location of the start-of-chain pointer is: DOS 2.0, offset 10AH; DOS 2.1, offset F6H; DOS 3.0, offset 128H; DOS 3.1, 3.2, and 3.3, offset 22H.

The simplest method for finding the segment where IBMDOS.COM is located is to display the far address at 0:80H, the vector for interrupt 20H (terminate process). This method does not work, of course, if a terminate-and-stay resident (TSR) program has hooked this interrupt. A more reliable pointer is the segment portion of the far address at 0:C1H, which is contained in an instruction that is a far jump to the DOS function dispatcher.

The first memory block contains the DOS file buffers, the file-control blocks used by the handle file I/O function calls, and any device drivers loaded by DEVICE statements in the CONFIG.SYS file. This block is established and owned by IBMDOS.COM, which does not have a program segment prefix (PSP). The block identification word in the first memory-control record, therefore, has the dummy value 08H.

The second memory block contains the resident portion of COMMAND.COM. The command processor, just like an application program, has a PSP. The third block is the master environment containing the COMSPEC, PROMPT, and PATH strings and any strings inserted with SET commands.

Subsequent memory blocks contain any TSR programs, followed by the currently executing process. Each resident program initially owns two blocks. The first contains a copy of the environment; for DOS 3.0 and later, this is followed (in the same block) by the name of the executable file from which the program was loaded. The program's other memory block contains the PSP and the program itself. When a program is loaded, it is allocated all remaining memory, so this block's control record begins with a *Z*. If a program releases memory by shrinking this block, the signature in this control record is changed to *M*, the size word is updated, and a new *Z* record is created for the memory released.

A program gets a pointer to its environment segment at offset 2CH of the PSP. The DOS *Technical Reference* recommends that a TSR program release its environment block to save memory. However, after deallocation the value at PSP offset 2CH still points to the same location, which is no longer owned by this process. The owner identification word in the deallocated memory block's control record is properly updated to reflect deallocation and possibly subsequent reallocation to another process. Furthermore, removing the environment means that the resident program cannot be subsequently identified; this might be more of a problem than the loss of several dozen bytes of memory.

This information is offered with a caveat: it is not documented and, though it has remained unchanged since DOS 2.0, no guarantee can be made that it will remain so.

TABLE: *Layout of Memory Control Record*

OFFSET	LENGTH	CONTENTS
0	Byte	Signature: 'Z' if last block in chain, 'M' otherwise
1	Word	ID of owning process (Segment address of its PSP)
3	Word	Length of block in paragraphs (excluding control record)
5	11 Bytes	Reserved (currently unused)

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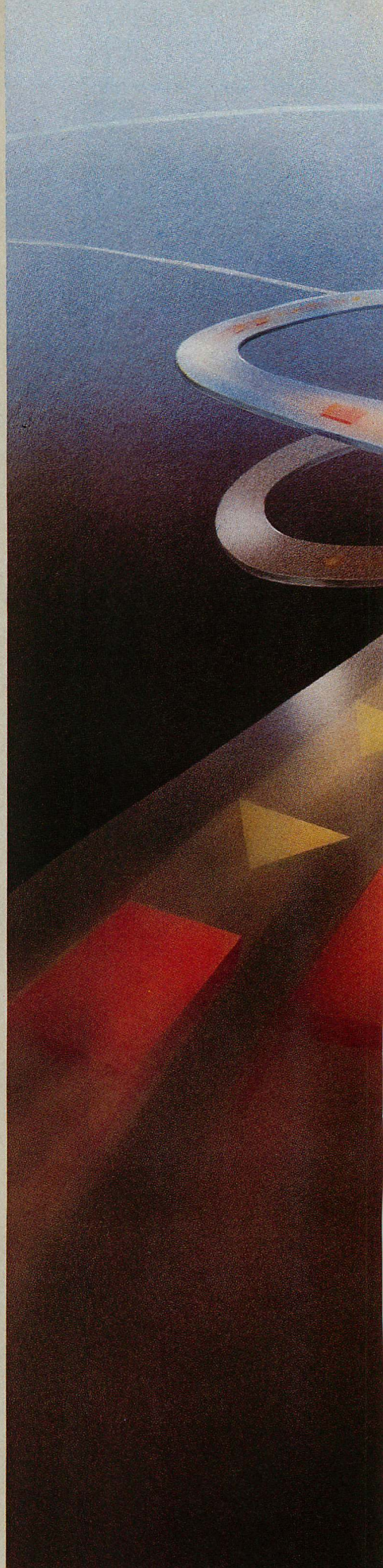
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Analyzing Network Traffic

The complexity of protocols in the typical LAN underlines the need for a network analyzer. The Sniffer is one such package.

J. SCOTT HAUGDAHL



Have you ever encountered something mysterious happening on your local area network (LAN)—something that defied explanation? Have you ever wondered what the LAN vendors aren't telling you? Do you really believe that vendor A's implementation of a standard protocol follows strict rules and is compatible with vendor B's implementation of the same protocol? The answers to these questions and more are yours with a LAN protocol analyzer.

LAN protocol analyzers do more than check for problems and analyze protocols. They also are quite useful for debugging a user's own network protocol, for developing systems software that relies on the vendor's underlying existing protocols, *and* for "sniffing out" elusive bits and overdue acknowledgements.

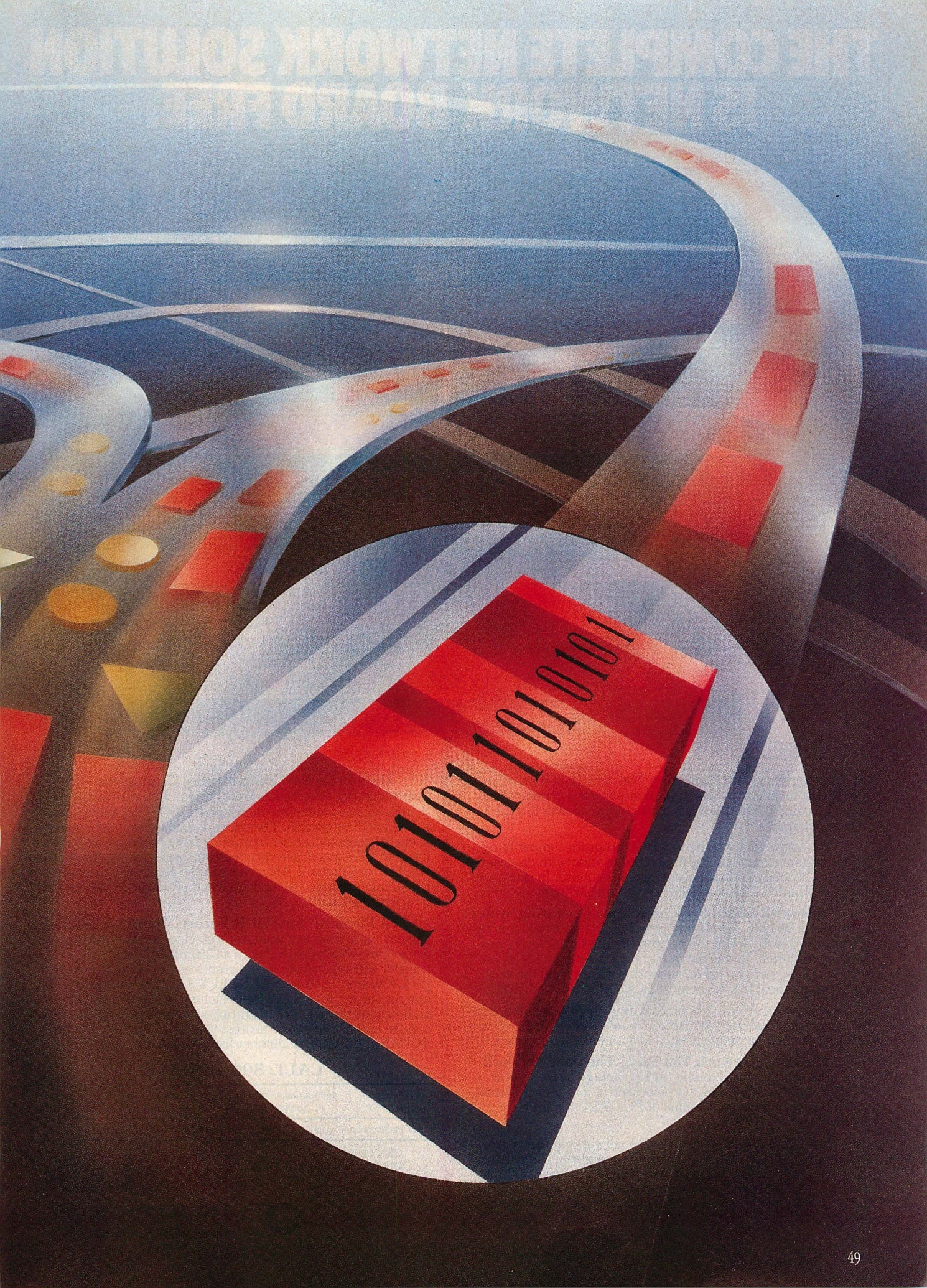
Recently, The Sniffer from Network General Corporation joined the melee of LAN protocol analyzers from vendors such as Excelan and Hewlett-Packard (HP). But The Sniffer is unique in that it can operate on both IBM's Token-Ring Network (for which it was developed) and Xerox's Ethernet. An ARCnet (Datapoint) option should be available soon. Also unique to The Sniffer is a suite of protocol interpreters that can break down protocols, layer by layer and vendor by vendor.

The ability to manage and diagnose problems in a LAN is inversely proportional to its size—the larger the LAN, the more difficult it is to handle. Gateways to wide area networks (WANs) and multiple-vendor protocols on the same network further complicate diagnosis. The design of some networks, such as the Token-Ring, prohibits simple workstations (with standard PCs and network adapters) from monitoring all traffic.

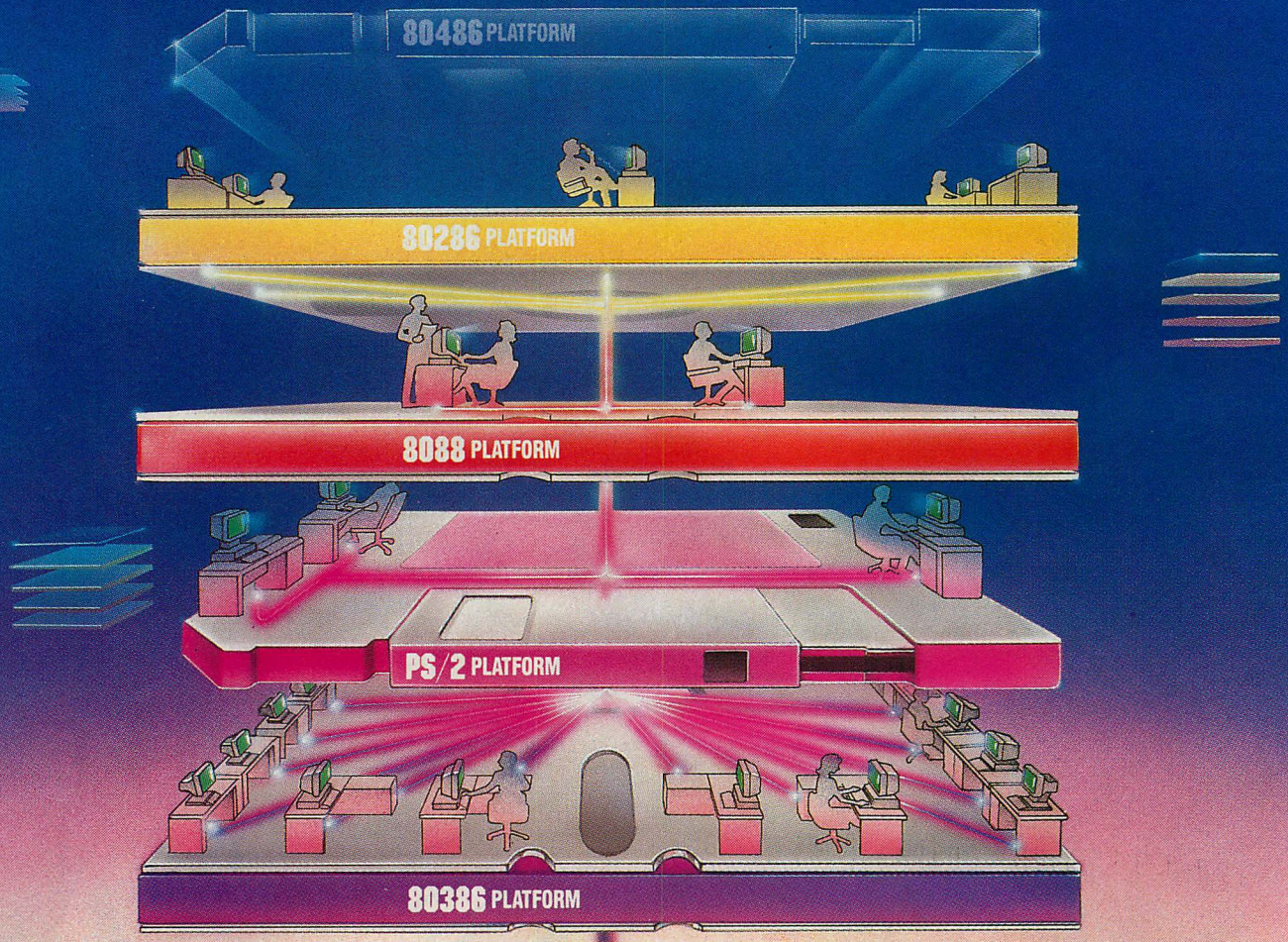
Network management typically entails managing resources by configuring, controlling access, changing, audit monitoring, and the like. The user typically relies on vendor software to perform these functions, but such software is usually weak in diagnosing problems (except at a high level).

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any protocol level, the manager can pinpoint a problem more readily. In general, the lower the layer, the more hardware-oriented the problem (including the cable); the higher the layer, the more software-oriented. The LAN analyzer also can verify that the network is operating properly as installed.

By monitoring day-to-day operation, the LAN manager can gather data for later statistical analysis of network, resource, workstation, and server utilization, time-outs, checksum errors, and the like. These data also can be used to define the network and analyze loads by injecting traffic back into the LAN. Data can even be purposely changed in order to detect how a file server handles bogus requests.

These analyzers probably benefit most the applications developer and the protocol developer. For the applications developer, they ensure that he is using protocols properly and efficiently; for protocol developers, they check for compatibility with other implementations or the proper operation of a new implementation. The accompanying sidebar, "What's in a Protocol?" summarizes the form and function of LAN protocols and describes the ISO (International Standards Organization) model to which many are designed.

One caveat: because a LAN analyzer is a powerful tool, it has the potential for misuse. All data traveling on the LAN are subject to capture and inspection by the analyzer. Security or access controls are bypassed, thus the only protection is data encryption. Analyzers with traffic-generation capabilities might also be used to generate false requests from a station.

ANALYZING THE ANALYZERS

Many LAN analyzers monitor various levels of protocols, and, not surprisingly, most are designed for the long-time standard, Ethernet. But comparing analyzers is inappropriate because of their range of strengths and weaknesses. One analyzer might work only on its vendor's network; another might not have a protocol breakout; and in another, the data might not log to disk in the background.

Ethernet LAN analyzers are available from Digital Equipment Corporation (DEC), Excelan, HP, Sun Microsystems, and Network General, among others. Token-ring analyzers are available in IBM's LAN Manager Program, which has limited functionality, and from Network General.

A LAN analyzer must capture all LAN traffic—all packets to all stations and at maximum back-to-back throughput. Typical adapter cards for a PC often cannot be used. On the Token-Ring, for example, the standard adapter card captures only the traffic destined for its own station; other packets are ignored. The PC's capacity to process messages is also important—a slow CPU may not assimilate all messages before the adapter's buffer area overflows. For these reasons, a combination of high-performance PCs or special workstations and specially modified or configured adapter cards is necessary.

When analyzing the activity on a LAN, bad packets can be as important as good ones. A bad packet can occur for many reasons, most of which are related to interference with the signal on the cable. The most common test for a bad packet is a cyclic-redundancy check (CRC), calculated as a function of the data in the packet. The receiver of a packet calculates the CRC and compares it with the CRC stored in the packet by the sender. Other bad packets include runts (smaller than the minimum packet size) and truncated packets (smaller than the length specified in the packet header).

In analyzing LAN activity, bad packets can be as important as good ones. A bad packet usually results from signal interference.

Most analyzers allow captured data to be viewed in realtime as they arrive from the network. However, events typically occur too quickly on the LAN to be analyzed as they happen. Therefore, the packets are placed in a *capture buffer*, along with a time stamp, for later analysis. The time stamp helps determine such information as response and acknowledgement times for fine-tuning the network or protocols.

In some analyzers, such as The Sniffer, the capture buffer must be turned off to save the captured data to disk; this limits the capture size to the capacity of the in-memory buffer. Others, such as the Excelan Lanalyzer, automatically spool the data to a hard disk as a background task while traffic is captured in the foreground.

In many debugging situations, the data packets of interest are interspersed with traffic from unrelated network equipment. Most analyzers offer a way to *filter* the traffic—to save only packets that meet specified criteria. For example, a filter could be set to capture only broadcast messages, or to discard all packets not destined for a particular station. A related facility, the *trigger*, allows the user to specify that data capture start or stop when a specific data pattern is encountered in a packet. The small capture buffers in some analyzers make filtering and triggering necessities on busy networks, as demonstrated by The Sniffer analysis of Ethernet described below. In addition to filtering traffic before capture, some analyzers can set extra filters for viewing already-captured data in order to cut down the volume of packets that must be traversed during analysis.

Once the traffic is captured, it can be displayed in many ways. The simplest form is a hexadecimal/ASCII display similar to the one used by DOS DEBUG. However, decoding the packet's meaning from these hexadecimal values is tedious and error prone. Therefore, most analyzers also include a set of *protocol interpreters*, which display a packet based on the protocol in use. Because the in-depth description of a single packet can become rather lengthy (often longer than a screen), analyzer displays allow the user to select the level of detail desired. The Sniffer, for example, can show both summary and detailed views on the screen for each packet.

Protocol interpreters can be dangerous if the user does not know the precise protocols being used. For example, Novell's NetWare uses the IEEE 802.2 Class 1 logical-link control (LLC) on the Token-Ring and no LLC on Ethernet. If the user places an 802.2 LLC interpret on an Ethernet running NetWare, the packet will be interpreted improperly. On The Sniffer, however, the protocol interpreter realizes when a field has no meaning and informs the user, who should suspect that the protocol does not follow the rules or that a different protocol is in use.

In both the Token-Ring and Ethernet, each station is identified by a 48-bit address assigned when the card is manufactured. This address is unique to the network card in that station. Many protocol analyzers allow the user to create a database that gives a mnemonic name to a station, which is displayed in place of a 12-digit hexadecimal number. For example, a station that operates as a server under NetWare might be named "NETWARE."

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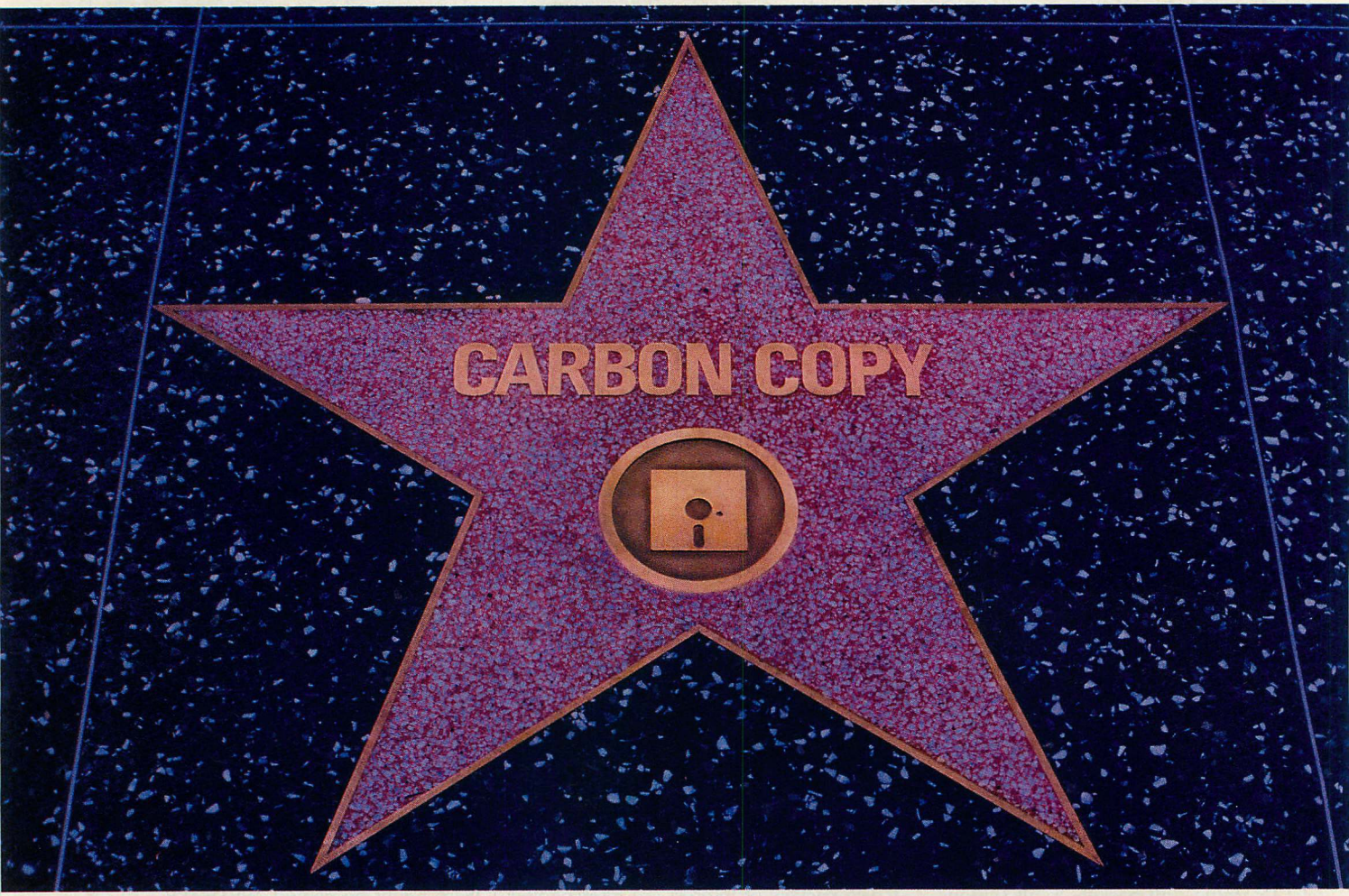
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In addition to details about each packet, many analyzers provide statistical summaries of network activity, including the realtime display of total packets received, total bytes received, error tallies, and network utilization with user-specified sampling intervals. Some also include histograms of activity for specific station addresses for analyzing traffic patterns and performance bottlenecks on the network. Other desirable features include portable operation and remote operation over a phone line. These allow a single analyzer to service multiple on-site networks or different off-site networks.

The Sniffer is not vendor dependent: it will operate on both the Ethernet and the Token-Ring networks, and it can be configured with several protocol interpreters. It delivers an overall unique and powerful performance, but, as do all such packages, it has a few weak spots as well.

SNIFFER BASICS

The Sniffer package comprises a Compaq Portable II, network adapter(s), The Sniffer software, and DOS. The Portable II is equipped with an 8-Mhz 80286, a 20MB hard disk, four expansion slots, and a memory-expansion area for adding a proprietary Compaq memory board. It can be ordered with an Ethernet adapter (3Com's EtherLink Plus), a token-ring adapter (Proteon's Token-Ring AT), or both network adapt-

WHAT'S IN A PROTOCOL?

A protocol is simply a set of conventions that allows two or more endpoints to communicate. Protocols consist of syntax, semantics, and timing. A protocol's *syntax* defines the bit stream (a series of ones and zeroes) by dividing it into fields. For example, the first 48 bits might be the source address, followed by 48 bits of destination address, 16 bits of packet type, and so forth. The *semantics* define the precise meaning of the bits within a field. For example, an address of all ones might be interpreted to be a broadcast message. The *timing* includes the raw data rate of the bit stream and time-outs between acknowledgements. Timing is critical to the smooth flow of information over a high-speed LAN.

When describing the syntax and semantics of protocols, vendors often refer to the open system interconnection (OSI) model developed by the ISO (International Standards Organization). The OSI is a seven-layer model for the connection of nonhomogeneous (multivendor) equipment in a network. (See "SNA Strategies," Art Krumrey, July 1985, p. 40.)

The bottom-most layer of the OSI, layer 1, is the physical link. The OSI reference model states that layer 1 must specify the encoding technique (differential Manchester encoding is used in both Ethernet and the Token-Ring Network), the signaling rate, and the interface to layer 2, data link. The physical layer does not specify the media type and connectors; each layer in the OSI model is independent of the layers above or below, and in this case, the physical signaling and bit rate are independent of the media type.

Layer 2 specifies the data-link procedures and packet format. It is this layer that first divides the bit stream from layer 1 for field interpretation. Example data-link procedures include the IEEE 802.2 LLC (logical-link control), HDLC (high-level data-link control), and SDLC (synchronous data-link control). It is broken into type 1 (connectionless) and type 2 (connection-oriented) services. Type 1 allows sending datagrams (one-time messages) with no prior connection or acknowledgements. Type 2 establishes a connection before the transfer of data and includes sequence numbers and acknowledgements.

The network layer, layer 3, supports internetworked environments. It recognizes an additional level of addressing and works in a gateway to route packets to other networks.

Layer 4 is the transport layer, supporting reliable communication between two endpoints, even on unreliable networks, such as Ethernet, that depend on datagrams. Ethernet systems do not implement IEEE 802.2 type 2 services. The transport layer adds sequence numbers, acknowledgements, and, depending on the class of service, error recovery.

The next is layer 5, the session layer, which enables the establishment, maintenance, and break-down of a session between two endpoints, by logical name. NETBIOS is often referred to as a session-level interface, even though it provides other services, including the sending and receiving of datagrams.

Layer 6, presentation, contains the encoding rules for data representation, such as character sets, integer representation, and floating point. Finally, the application layer (7), provides network services, such as file transfer, terminal emulation, and logging into a file server. The application layer is often confused with applications such as spreadsheets and word processors, which are really at "layer 8." (One correct example of a PC LAN layer-7 application is the shell software in the NetWare workstation.)

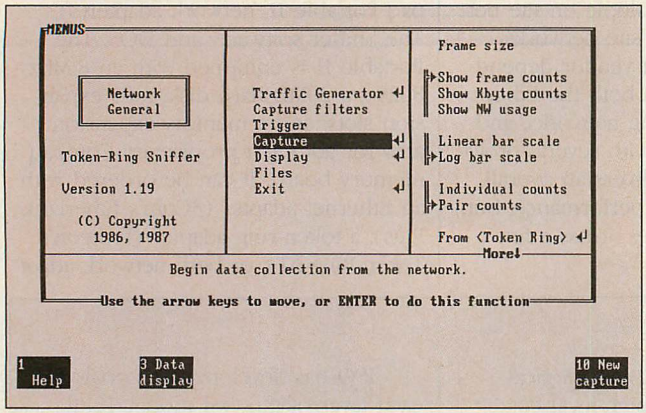
ISO has developed protocols for each layer of the OSI model. IEEE has developed protocols for layers 1 and 2. The most-used IEEE protocols are IEEE 802.2, 802.3 (1- or 10-Mbps baseband, bus topology for Ethernet and AT&T Information Systems' StarLAN), 802.4 (1- to 10-Mbps Token Bus broadband, the bus topology used in the MAP specification), and 802.5 (1- or 4-Mbps, baseband, the ring topology for the IBM Token-Ring). The IEEE specifications deviate from the OSI model somewhat in that the 802.3, 802.4, and 802.5 standards specify layer 1 and the lower half of layer 2. IEEE 802.2 is really the upper half of layer 2 (for additional information on this subject see "LAN Hardware Standards," Art Krumrey and John Kolman, June 1987, p. 54).

Other popular protocols were developed before the OSI model, including the IBM SNA, Xerox XNS, and TCP/IP used by the U.S. Department of Defense. However, the layering is very similar to the model. SNA provides the functionality of layers 1 to 7, XNS covers layers 3 to 7, and TCP/IP covers layers 3 and 4.

All of this complexity underlines the need for LAN protocol analyzers. LAN protocols consist of several layers performing differing tasks. Designers want efficiency and functionality. Users want protocols to work transparently and fast. The complexity of such systems can be burdened further when protocols from different vendors operate on the same LAN—Ethernet is one such environment. Often, many different protocols are in use at any given time to support a variety of applications. A PC might use one set of protocols when emulating a terminal and another when communicating with a terminal server, because these services often are offered by different vendors.

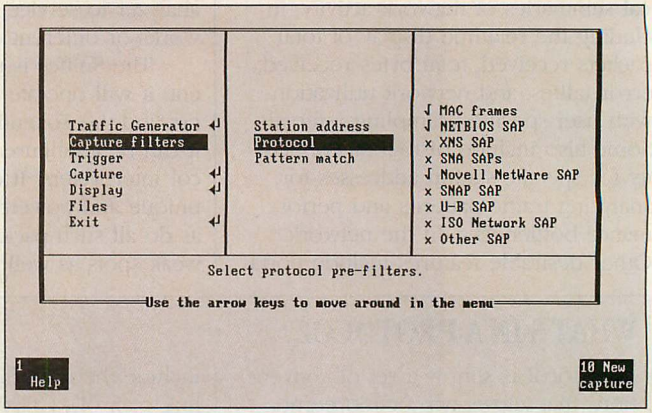
—J. Scott Haugdahl

PHOTO 1: *The Sniffer Opening Menu*



Three menu windows are displayed by The Sniffer; the center window displays the items that can currently be chosen. Function key mappings are shown in boxes at the bottom of the screen and change depending on the menu in use.

PHOTO 2: *The Sniffer Protocol Filter Menu*



In this screen, the "Capture filters" option of the main menu has been selected, bringing up the set of choices in the center window. Options for "Protocol" are shown in the rightmost window; selected options are checked.

ers. Both take advantage of the 16-bit PC/AT-compatible bus.

Proteon's Token-Ring AT was designed to be more secure than Ethernet by eliminating an option that allows all frames to be received by any station. For this reason, the Proteon adapter uses a modified Texas Instruments' token-ring chip set normally used only in the initial design of a token-ring adapter. Both Proteon and IBM production adapters contain the more secure chip set.

To physically connect an Ethernet network, the user must access the existing external transceiver and transceiver cable in a thick-cable network. The Sniffer's Ethernet adapter contains a built-in transceiver designed for thin-cable (RG-58/U) installations. Using the built-in transceiver requires opening the machine and changing the configuration switches on the Ethernet card. This is particularly unfortunate for small sites that have only thin Ethernet cable, because they are not likely to have an external transceiver. For Token-Ring networks, the connection is uncomplicated, requiring only the standard adapter drop cable used with the IBM PC Token-Ring Adapter.

CUSTOMIZED SOFTWARE

The Sniffer software consists of a single, rather large .EXE file. When the machine is booted, AUTOEXEC.BAT brings up a menu. The menu options depend upon the configuration—Ethernet, Token-Ring, or both. The user also can exit to DOS and use the machine as a standard PC. The DEMO option is handy for demonstrating how to operate The Sniffer when a network cannot be accessed.

In The Sniffer 1.19, the version reviewed, the various protocols supported are built into the .EXE program—at time of purchase, the buyer specifies the protocols desired, which then are customized into the .EXE file. With version 1.20, the programmer can extend The Sniffer's protocol interpretation by adding custom protocols or even writing an individual interpreter for any protocol supported by Network General, such as the TCP/IP (Transport Core Protocol with Internet Protocol).

Available protocol suites include several TCP/IP varieties, including ARP, TCP, UDP, ICMP, DNS, and Telenet; Sun Microsystems' Network File System (NFS) protocols, including RPC, YP, and PMAP; ISO 8473 IP; ISO 8073 Transport Protocol (TP) class 4; Xerox Network Systems (XNS) protocols used by Xerox, 3Com 3Plus, and Ungermann-Bass, including PEP, SPP, RIP, and Courier; the Server Message Block (SMB) protocol developed by Microsoft for Microsoft Networks and also used in the IBM PC LAN Program; NETBIOS; NetWare Core Protocol (NCP), used for dialogue between the workstation and a file server; the IEEE 802.2 LLC Type 1 and Type 2 protocols used by virtually all Token-Ring and Ethernet LANs; and the media-access control (MAC) protocol, a superset of the IEEE 802.5 protocol used in the IBM Token-Ring.

Operation of The Sniffer is controlled entirely by menus. The menus use a sliding-window display in which the menu cursor is always in the center of the screen and the user slides three windows left or right by pressing the appropriate arrow key. The left-hand window shows the previous menu, the center window has the present choices to be selected, and the right-hand window displays the subchoices for the selection made in the center menu.

Although this type of window display is not new, it has been used very little in the PC world, and it is an extremely straightforward method. In fact, The Sniffer was put to work right out of the box—without a look at the manual. Only later was a sheet found entitled, "For Those That Don't Read Manuals." The on-line help, available by pressing F1, is limited.

The Sniffer opening menu (see photo 1) is shown selecting the capture option. The submenus, which include the options for capture, are displayed to the right. A double-thick vertical bar with an arrow indicates that the options to the right of the bar are mutually exclusive. To select an option, the user moves the cursor up or down to its title, then presses the space bar.

The Sniffer collects all packets (good and bad) and breaks them down into the higher-level protocols based on the frame format. It can filter packets according to a single station address—a particular protocol, such as NetWare, using the service access point (SAP) at the IEEE 802.2 LLC level, or a pattern match limited to four bytes plus an offset. The LLC is the highest level that can be filtered. The screen in photo 2 shows a menu with the protocol-filtering option. In this menu, more than one option can be selected at a time; a check mark next to the option indicates it is turned on.

Once packets are in the capture buffer, they can be either displayed or saved for later analysis. One major disadvantage of The Sniffer is that it currently supports a maximum buffer size

of only 256KB. Such a buffer can fill rapidly even with filters set. However, the user can elect to stop when the buffer fills or to capture packets in a circular fashion, overwriting previously captured frames. The only way to save the buffer is to stop the capture momentarily, save to a file, and start a new capture that erases the contents of the old capture buffer. Network General indicates that extended AT memory will be supported in the near future. Supporting up to 15MB of additional memory certainly would make the buffer problem less of an issue.

The Sniffer was tested in two completely different LANs. The first was a controlled token-ring environment used in-house by Architecture Technology, a consulting firm in Minneapolis, Minnesota; the second was an uncontrolled Ethernet environment at a major university. The token-ring environment consisted of a NetWare/86 file server operating on an AT compatible, The Sniffer itself, and a single AT workstation. The Ethernet environment consisted of several Sun Microsystems UNIX-based workstations, HP minicomputers, Data General minicomputers, a VAX 11/780, and Bridge Communications CS/100 communication servers with several attached terminals.

SNIFFING TOKEN-RINGS

The MAC frame format as defined by IBM is a superset of the format defined by IEEE 802.5 (see figure 1). The optional source-routing field is unique to IBM, as are several vector identifications not found in the IEEE version. The vectors are split into *major vectors*, which in turn are divided into *subvectors* (see "The Token-Ring Solution," J. Scott Haugdahl, January 1987, p. 50).

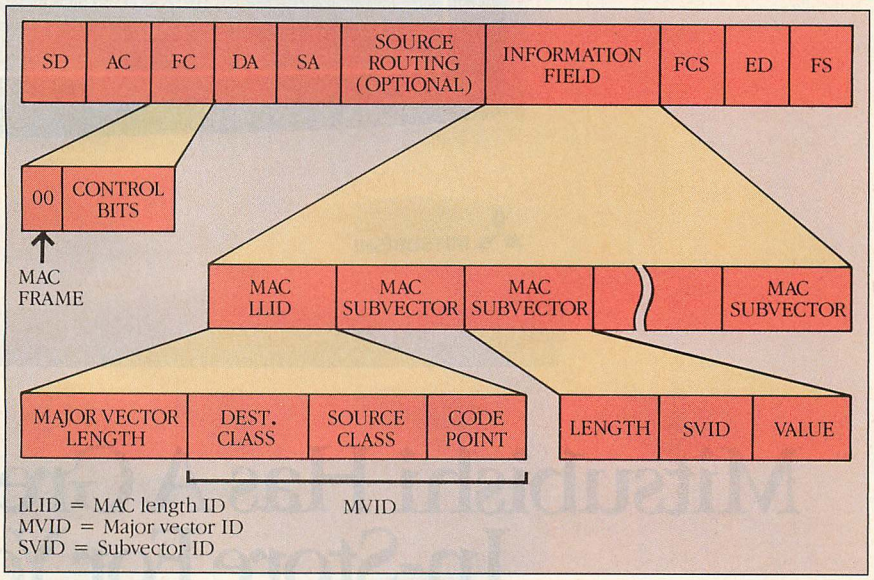
A good way to examine the operation of MAC frames is by using The Sniffer to check the token-insertion sequence that occurs when an AT (named JSH AT in figure 2) joins the network. Figure 2 is a Sniffer-generated printout of the frames in summary format. The printout shows only the high-level protocol within the frame, because it was the option selected for viewing. Whatever format the user selects to display—summary, detail, or hexadecimal—also can be printed or saved to a DOS file.

The columns in the listing include the frame number, the relative time from beginning of capture in milliseconds (The Sniffer's time-stamping resolution), the destination name, the source name, and the summary of the frame protocol. The source and destination can be displayed as either the 48-bit token-ring address or as a name, for easier station recognition. The time can be displayed and printed in three different ways: time from the start of capture, absolute (clock) time, or the delta time since the last frame.

The Sniffer's delta time is somewhat nonintuitive—if a frame arrives less than a half-millisecond after a previous frame, the delta time reads zero. If this happens in rapid succession, it appears as if many frames are arriving in the same one-millisecond interval. When the time between two nonadjacent frames is important, the time stamp should be used, not the delta.

Referring to figure 2, before JSH AT is inserted into the ring, The Sniffer is the active monitor and the NetWare server is the standby. The monitor MAC frames are broadcast about every seven seconds. Frame 7, at 18.762 seconds, is a *ring purge* by the active monitor, meaning that the token was lost. The likely cause is that the JSH AT has activated the relay in the multistation access unit (MAU), interrupting the nor-

FIGURE 1: *IBM-defined MAC Frame Format*



IBM's Token-Ring medium access control (MAC) format is a superset of the IEEE 802.5 MAC frame. IBM added the source routing field and new vector IDs.

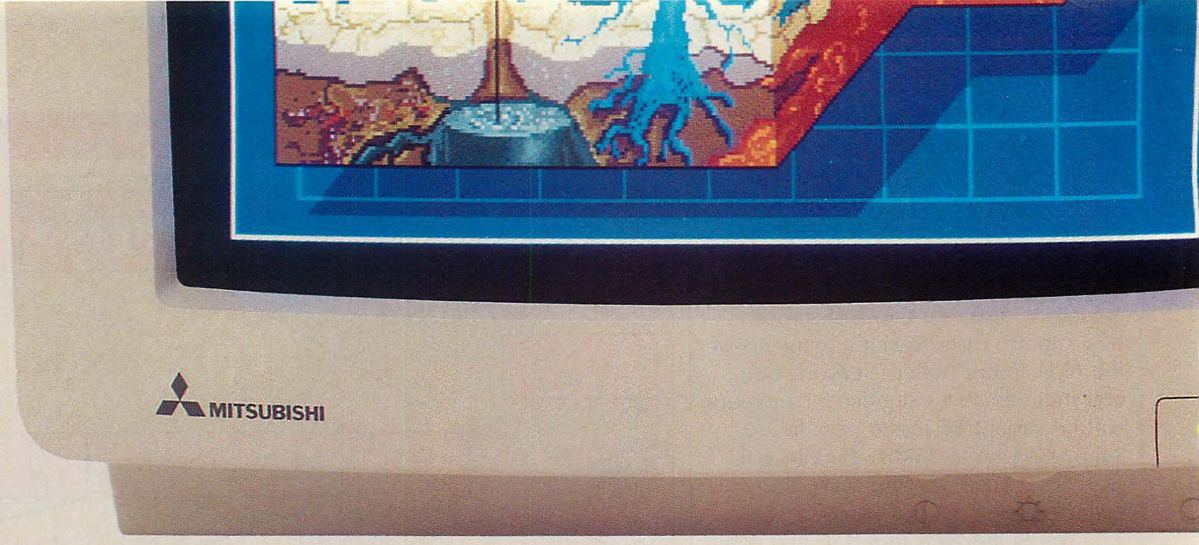
FIGURE 2: *A Sniffer Summary of MAC Frames*

```
Sniffer data collected on 5/22/87 at 14:57:36, file C:\CAPTURE\ATC_TR\3H.TRC, Page 1

 Frame Rel time    Destination  Source       Summary

M   1    0.000    Broadcast    ATC Sniffer  MAC Active Monitor Present
    2    0.013    Broadcast    NetWare      MAC Standby Monitor Present
    3    6.927    Broadcast    ATC Sniffer  MAC Active Monitor Present
    4    6.942    Broadcast    NetWare      MAC Standby Monitor Present
    5   13.854    Broadcast    ATC Sniffer  MAC Active Monitor Present
    6   13.870    Broadcast    NetWare      MAC Standby Monitor Present
    7   18.762    Broadcast    ATC Sniffer  MAC Ring Purge
    8   18.763    JSH AT       JSH AT       MAC Duplicate Address Test
    9   18.764    Broadcast    ATC Sniffer  MAC Active Monitor Present
   10   18.765    JSH AT       JSH AT       MAC Duplicate Address Test
   11   18.765    LAN Manager  JSH AT       MAC Report SUA Change
   12   18.778    Broadcast    JSH AT       MAC Standby Monitor Present
   13   18.779    LAN Manager  NetWare      MAC Report SUA Change
   14   18.780    Param Server JSH AT       MAC Request Initialization
   15   18.781    Param Server JSH AT       MAC Request Initialization
   16   18.782    Param Server JSH AT       MAC Request Initialization
   17   18.782    Param Server JSH AT       MAC Request Initialization
   18   18.788    NetWare      JSH AT       NCP C Find nearest file server
```

In this sequence output by The Sniffer, the station JSH AT is entering the ring. Frame 7 is a ring purge by the active monitor, meaning that the token was lost.



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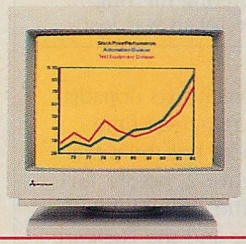
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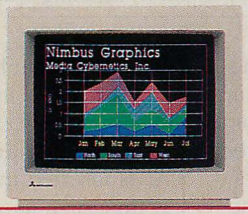
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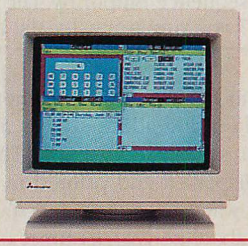
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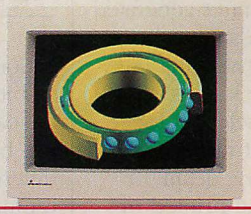
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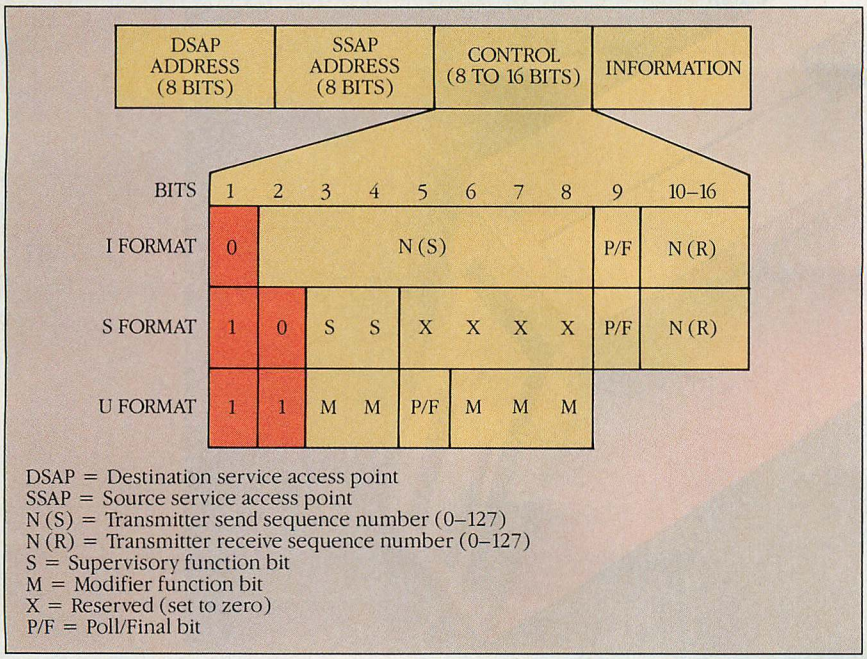


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FIGURE 3: *IEEE 802.2 LLC in Token-Ring Frame*



The logical link control (LLC) format, used by the Token-Ring Network, consists of three types of frames. I (Informational) frames are used for sequenced messages, U (Unnumbered) frames are for unsequenced, unacknowledged messages, and S (Supervisory) frames are used for status and flow control.

mal flow and causing the lost-token timer to expire at the active monitor.

Following the ring purge, the token begins flowing again. In frames 8 and 10, JSH AT checks whether any other station has its address. None does, so the next step is to notify the LAN manager (a management function unique to IBM) that the upstream address of JSH AT has changed (by being inserted into the ring). This is part of a neighbor-notification process in which the upstream-neighbor address (the active adapter before JSH AT) is determined based on the monitor broadcast packets. The LAN manager is targeted by broadcasting a functional address (a special broadcast group address) that can be picked up by any station listening for that address. Because the review test environment has no LAN manager, this frame goes unprocessed. In frame 12, JSH AT broadcast its standby monitor frame.

In frames 14 to 17, a burst of request-initialization frames is sent to the functional address for a parameter server, an optional component not present in this network. The IBM Token-Ring Bridge Program, for example, acts as a parameter server and supplies information, such as the ring number, for use in source routing as well as determining problems. From this point on, JSH AT is ready to use the Token-Ring to communicate with NetWare or other ring resources.

In addition to carrying MAC information, the basic Token-Ring frame (or 802.3 Ethernet for that matter) can carry LLC frames. Figure 3 shows the IEEE 802.2 LLC frame encapsulated within the information field of the Token-Ring frame. The two bits adjacent to the right of the frame field-control byte indicate how the information field is to be interpreted; a 00 indicates a MAC frame; a 01, an LLC frame. An important LLC field is the destination-service-access point (DSAP), which informs the receiving frame handler which process is to receive the frame. The DSAP values are assigned to vendors by the IEEE 802 committee to ensure that each is unique.

The control field contains detailed information on how to handle the LLC frame itself. Frames can be informational (I), supervisory (S), or unnumbered (U). NetWare employs the simplest—the U frame—used for Type 1 operation (connectionless with no sequence numbers or acknowledgements). The I frame is used for connection-oriented service, a Type 2 operation in which sequence numbers are used at the LLC level. NetWare uses sequence numbers at the transport level rather than the LLC Type 2 level. This simplifies the process of porting NetWare to networks not having connection-oriented services.

If the DSAP is E0, The Sniffer interprets the frame as a NetWare frame and treats the rest of the frame accordingly. Photo 3 shows The Sniffer view of a frame containing a NetWare open-file request. Three views are available to the user: summary, detailed, and hexadecimal. Any or all of these views can be turned on and off. As the user moves the cursor around inside a view window, the subordinate window changes accordingly. For example, the user can select the summary window to display only the highest protocol recognized by The Sniffer within the frame or to display the encapsulated view, as shown in photo 3. Then, if the cursor were moved to, say, the NCP portion of the frame in the summary window, the detail window would contain an English explanation of the NCP request and the hexadecimal window would highlight the actual location of the bits in the frame, along with their ASCII (or EBCDIC) representations. Photo 4 shows only the detail window, highlighting the NCP open-file request. All NCPs are carried across the Token-Ring using the same basic format.

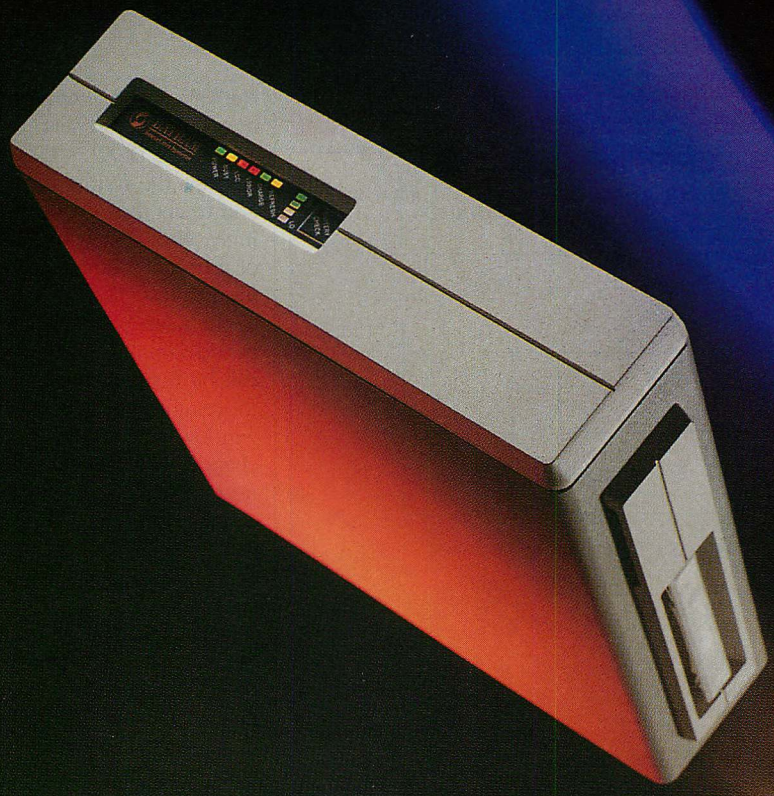
By examining the packets, it can be deduced that NetWare is not purely XNS. Novell uses the standard XNS IP format, but not the standard XNS-sequenced packet protocol found in the internet data field. This is replaced instead by the NCP, which contains its own Novell-defined fields, including a sequence number field.

NetWare does, however, adhere to the routing information protocol (RIP) when multiple servers and/or gateways are used to create an internet environment. In testing, The Sniffer revealed that a Novell server broadcasts a RIP frame about once every minute to notify all attached servers that it is active on a certain network. The network, called an *object network* in XNS terminology, is identified by a unique 32-bit identifier issued to each installed network card in the server when NetWare is installed.

The NetWare dialogue between a workstation and a file server covers only four layers of protocol, rather than the full seven of the open-system interconnection (OSI) reference model. The four layers are physical, data link, network, and transport.

A SIMPLE REQUEST

What is a typical, simple DOS request/protocol flow? Figure 4 shows the output of network activity for a DIR com-



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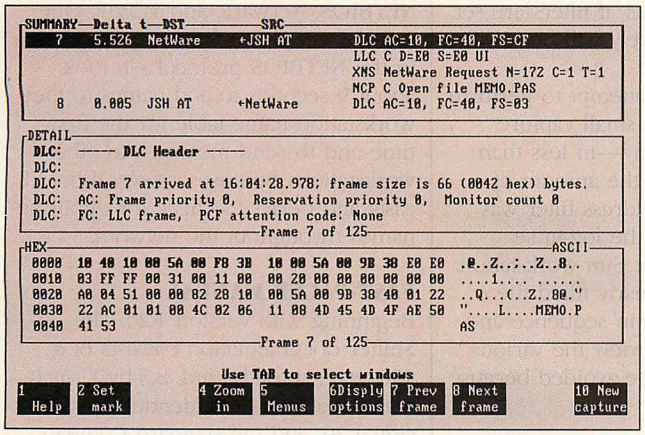
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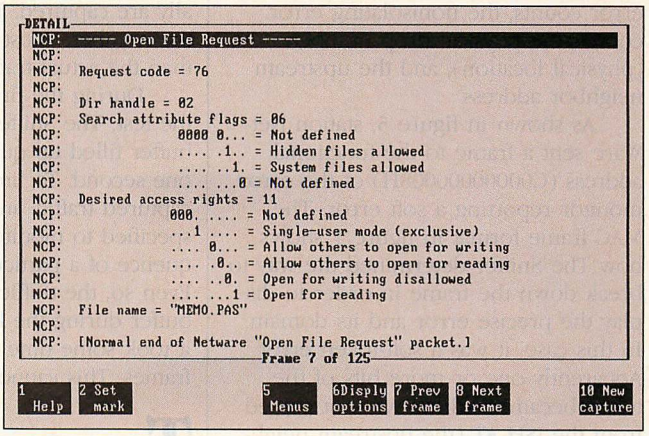
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PHOTO 3: *Window with Open-file Request*



Three levels of detail are shown. The highlighted line in the SUMMARY window is elaborated in the DETAIL window. The bytes in the frame representing data in the DETAIL window are shown in the HEX window.

PHOTO 4: *Close-up Open-file Request Window*



A full-screen option provides a larger viewing area for the DETAIL view of the frame—in this case, a NetWare Core Protocol (NCP) request. Function keys can move the user through the frames while remaining in the detailed view.

mand performed at \USR\JSH\MEMO. Instead of using relative time, the bytes are shown for a simple directory listing of 10 files. The summary column also shows the encapsulation of each protocol used. The filter was set to JSH AT to eliminate other network traffic.

The directory command starts with frame 10, with a NetWare **Get volno 2 stats** command. NetWare responds with the statistics, then JSH AT (that is, DOS) requests the directory path of handle 02—twice. Eventually the search parameters are set and the file names are returned, starting with the DOS **find first entry** and continuing each time the DOS **search for next entry** is invoked at JSH AT. The NetWare sequence number (N) is incremented for each send/reply frame. The C indicates the NetWare connection number and the T, the task-identification number.

The DIR request ends at frame 47; frames 48 and 49 are present because the prompt had been set previously to the path (using PG). The total bytes passed over the network to do a DIR *.* on 10 files was 2,709 bytes. Using this technique, a user can easily determine the protocol (as well as DOS) overhead when issuing DOS commands from various LANs.

USEFUL FEATURES

Triggering in The Sniffer is limited to two bytes at a given offset from the beginning of the frame, or from the beginning of the LLC portion of the frame. The user can specify the trigger to occur when the pattern is present or not present. The trigger also can be combined with the filter so that only frames from a certain station are checked. This allows capturing from a significant event forward, starting a capture, for example, when an application from a certain station locks a file. The trigger also can be used to stop a capture, thus receiving data before the event. Stopping the capture when the buffer is full is also a trigger function.

The Sniffer's traffic-generation feature can be used to test a token-ring under a constant load. The user can specify the number of bytes to send, where to send them (or all stations broadcast), and the delay (in milliseconds) between sending frames. When the frames are being sent, The Sniffer displays the frame count and kilobytes-per-second transmission throughput.

While The Sniffer is transmitting frames, none can be captured except by another Sniffer. Capturing should be allowed to continue because the user may, for example, generate transmit frames at relatively infrequent intervals.

When the maximum token-ring packet size of 4,048 bytes was specified, with no delay between sending, The Sniffer was able to sustain a transmission rate of approximately 330KB per second, or 2.64 Mbps, which consumed about 66 percent of the 4-Mbps token-ring bandwidth. When various DOS commands were performed from JSH AT to NetWare, very little degradation was noticed because of three factors—token access was fair, only three stations were on the network, and the workstation and server had the overhead required to carry out the request.

To observe the token-passing overhead, the packet size was reduced to 18 bytes. With no delay between sending, The Sniffer was able to send approximately 20KB per second. This indicates that the more data sent in a frame, the more efficient is the use the network. Of course, in fairness to others trying to access a shared resource, the file-server vendor usually sets a limit on the number of data bytes that can be transferred at any one time so that requests for service are handled in round-robin fashion. For example, The Sniffer showed that, with NetWare, 1,024 bytes are transferred when DOS files are loaded or copied.

The Sniffer's transmit feature also can be used to determine how a station behaves when receiving unexpected packets. In addition to specifying the destination address, the user can set the first 16 bytes of the frame to meet certain protocol criteria.

REPORTING ERRORS

One of the strengths the Token-Ring Network has over Ethernet is its ability to detect and report ring errors caused by adapter or wiring problems. Each adapter is constantly monitoring the bit stream for errors, even when it is not sending or receiving traffic. Thus, errors can be isolated between itself and its upstream neighbor (the prior physically-attached station).

When a station detects an error on the ring, the Token-Ring maintains and stores error counts for about two seconds. During this interval, it sends an error frame to the functional address of the error monitor. The IBM LAN Manager Program, for example, accepts error frames. Figure 5 shows The Sniffer's detailed output of an error-reporting MAC frame. The major vector type is a "Report Software Error" (see figure

1). Within this major vector are four subvectors that indicate the isolating error counts, the nonisolating error counts, the physical drop number (physical location), and the upstream neighbor address.

As shown in figure 5, station NetWare sent a frame to the functional address (C00000000008H) of the error monitor reporting a soft error. The MAC frame format in figure 1 shows how The Sniffer determined the way to break down the frame in order to display the precise error and its domain. In this case, it was a soft-token error. Apparently one or more bits of the token became garbled when it passed from the JSH AT (the upstream neighbor of NetWare). The NetWare adapter corrected the error and passed on a normal token. This particular soft error is rare, but it does occur. The problem might have been bad cabling between the JSH AT and NetWare—perhaps a distance or impedance problem, or outside interference.

ETHERNET OPTIONS

The Sniffer's operation on Ethernet is basically the same as it is on the Token-Ring except its options are different. For example, on Ethernet, The Sniffer monitors for bad packets only, such as bad CRC, collision fragments, or alignment errors. It also provides a cable-check option to check for an open or shorted cable.

The university Ethernet environment used for testing The Sniffer is not the typical Ethernet. The most common configuration is an office system with an average bandwidth utilization of 1 percent of the 10 Mbps available. Such a configuration is often used to substantiate the old argument that Ethernet has plenty of bandwidth for most applications. Of course, spikes in usage can reach upwards of 90 percent, depending upon the sampling period.

It therefore was surprising to see the university Ethernet operate at a sustained average of 20 percent of The Sniffer's network-utilization scale. The scale also indicated the peak utilization, which was about 60 percent. These figures were confirmed by a Sun Microsystems workstation set up to monitor protocol statistics and network utilization. The only difference was that the Sun results showed peaks of more than 90 percent, indicating that The Sniffer's sampling period was longer than the Sun's; the Sun sampling period can be adjusted, but The Sniffer's cannot. In addition, all of The Sniffer realtime monitoring option scales—utilization, bytes per second, and frames per second—are only for frames that actually are captured. Thus, if filters are set, the numbers most likely will be lower than the actual traffic.

During the first attempt to perform the test, The Sniffer's small capture buffer filled up quickly—in less than one second. To limit the amount of captured traffic, an address filter was specified to monitor the log-in sequence of a particular Sun workstation. Even so, the traffic nearly filled the buffer during the log-in sequence and it took some time to view the various frames. This cannot be avoided because the resolution of the capture filter is at the data-link level. The user can, however, filter packets further at higher-level protocols when displaying the captured frames. It would be helpful if The Sniffer had a search-for-data option to scan for specific data in the capture buffer similar to a word processor's search-for-word option.

The Sniffer should have a search-for-data option, similar to a word processor's search-for-word option, to scan its capture buffer.

One interesting test determined if The Sniffer would display the user's password in one of the frames: kudos to Sun because the password happened to be encrypted (and The Sniffer cannot reveal encrypted data). However, The Sniffer did reveal the password in a captured log-in NetWare sequence. These occurrences emphasize the risk in maintaining such tools. Besides passwords, other sensitive proprietary data could be captured easily as they move between a PC and a file server.

Close examination of the Ethernet frames also revealed that Sun does not use the 802.2 LLC protocol. In fact, it uses no LLC at all. It captures a packet as an Ethernet frame with the type field equal to 0800H, indicating that it is an IP frame and is handled accordingly in the workstation (or server, or gateway). Thus, frames pass directly from the physical layer to the network layer.

Included with The Sniffer (and The Sniffer demonstrator) are several captures from various networks: samples of 3Com 3Plus, SNA/APPC (System Network Architecture with Advanced Program-to-Program Communication), NETBIOS, NetWare, and TCP/IP. One capture sample revealed a poor design in the NETBIOS protocol—it took about 9 seconds to add names to the workstation name table for the first time and to send messages to other workstations because of several broadcasts and delays to check for duplicate names throughout the network.

FAST-PACED MANUAL

Beginning with version 1.20, The Sniffer documentation consists of a 150-page, spiral-bound, 8.5-by-11-inch manual, a 50-page addendum for version 1.20, and the standard Compaq documentation for DOS 3.2 and the Portable II. The two Sniffer documents are arranged for quick installation. The manual begins with three detailed examples that illustrate the use of The Sniffer in common situations. Two short sections follow that describe general operation and navigating the menu system. Appendixes describe the capture-file format, report how to extend protocol interpreters, and provide troubleshooting help. Another appendix provides an overview of the token-ring and further references.

The manual also has a useful diagram that shows the order in which The Sniffer performs operations. For example, packets are filtered before the trigger criteria are checked or statistics are collected. The nature of the menu system is so intuitive that this diagram may be all the user needs.

Because The Sniffer has been upgraded so often, the major documentation has been unable to keep up. Although a second, separate document complicates the search for information, the addendum contains a handy combined index that covers both the main manual and the addendum. Some of the features documented in the addendum include a selection for audible clicks when packets are received, a pseudo-live playback of captured data, and partial frame capture to preserve more capture buffer space.

PROTOCOL INTERPRETERS

With The Sniffer version 1.20, the user can write a custom protocol interpreter by extending the one that is provided with The Sniffer package. A protocol interpreter is a set of routines that is given a pointer to data somewhere within a frame. This interpreter has four tasks: to generate one or more short text lines about its protocol level for display in the summary window, to

FIGURE 4: *Output of Network Activity for a DIR Command*

```
Sniffer data collected on 5/27/87 at 14:06:36,
file C:\CAPTURE\ATC_TR\17H.TRC, Page 1

Frame Bytes    Destination  Source       Summary

    2    48  Error Mon.   JSH AT       DLC AC=18, FC=00, FS=03
                                       MAC Report Soft Error
    6    32  Broadcast    JSH AT       DLC AC=18, FC=06, FS=CF
                                       MAC Standby Monitor Present
    9    32  Broadcast    JSH AT       DLC AC=18, FC=06, FS=CF
                                       MAC Standby Monitor Present
   10    58  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=156 C=1 T=1
                                       NCP C Get volno 2 stats
   11    83  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=156 C=1 T=0
                                       NCP R OK Vol SYS stats
   12    58  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=157 C=1 T=1
                                       NCP C Get dir path of handle 02
   13    72  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=157 C=1 T=0
                                       NCP R OK Path=SYS:USR/JSH/MEMO
   14    58  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=158 C=1 T=1
                                       NCP C Get dir path of handle 02
   15    72  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=158 C=1 T=0
                                       NCP R OK Path=SYS:USR/JSH/MEMO
   16    56  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=159 C=1 T=1
                                       NCP C Dir search parms for [null]
   17    61  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=159 C=1 T=0
                                       NCP R OK Next=-1
   18    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=160 C=1 T=1
                                       NCP C Dir search *.*
   19    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=160 C=1 T=0
                                       NCP R OK File=MEMO.BAK
   20    73  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=161 C=1 T=1

Sniffer data collected on 5/27/87 at 14:06:36,

file C:\CAPTURE\ATC_TR\17H.TRC, Page 2
                                       NCP C Set handle for /USR/JSH/MEMO
   21    55  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=161 C=1 T=0
                                       NCP R OK
   22    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=162 C=1 T=1
                                       NCP C Dir search *.*
   23    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=162 C=1 T=0
                                       NCP R OK File=GETSTR.INC
   24    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=163 C=1 T=1
                                       NCP C Dir search *.*
   25    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=163 C=1 T=0
                                       NCP R OK File=TEMP.PAS
   26    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=164 C=1 T=1
                                       NCP C Dir search *.*
   27    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=164 C=1 T=0
                                       NCP R OK File=GETINT.INC
   28    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=165 C=1 T=1
                                       NCP C Dir search *.*
   29    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=165 C=1 T=0
                                       NCP R OK File=MEMO.DAT
   30    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=166 C=1 T=1
                                       NCP C Dir search *.*
   31    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=166 C=1 T=0
                                       NCP R OK File=LOADHELP.BAK
   32    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=167 C=1 T=1
                                       NCP C Dir search *.*
   33    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI

Sniffer data collected on 5/27/87 at 14:06:36,
file C:\CAPTURE\ATC_TR\17H.TRC, Page 3
                                       XNS NetWare Reply N=167 C=1 T=0
                                       NCP R OK File=PHONE.DAT
   34    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=168 C=1 T=1
                                       NCP C Dir search *.*
   35    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=168 C=1 T=0
                                       NCP R OK File=LOADMEMO.PAS
   36    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=169 C=1 T=1
                                       NCP C Dir search *.*
   37    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=169 C=1 T=0
                                       NCP R OK File=MEMO.PAS
   38    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=170 C=1 T=1
                                       NCP C Dir search *.*
   39    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=170 C=1 T=0
                                       NCP R OK File=MEMO.COM
   40    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=171 C=1 T=1
                                       NCP C Dir search *.*
   41    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=171 C=1 T=0
                                       NCP R File not found
   42    64  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Request N=172 C=1 T=1
                                       NCP C Dir search *.*
   43    87  JSH AT       NetWare      DLC AC=10, FC=40, FS=03
                                       LLC C D=E0 S=E0 UI
                                       XNS NetWare Reply N=172 C=1 T=0
                                       NCP R File not found
   44    58  NetWare      JSH AT       DLC AC=18, FC=40, FS=CF
```

FIGURE 4: *Continued*

```
                                    LLC C D=E0 S=E0 UI
                                    XNS NetWare Request N=173 C=1 T=1
                                    NCP C Get volno 2 stats
45   83  JSH AT       NetWare       DLC AC=10, FC=40, FS=03
                                    LLC C D=E0 S=E0 UI
                                    XNS NetWare Reply N=173 C=1 T=0
                                    NCP R OK Vol SYS stats
46   55  NetWare      JSH AT        DLC AC=18, FC=40, FS=CF

Sniffer data collected on 5/27/87 at 14:06:36,
file C:\CAPTURE\ATC_TR\17H.TRC, Page 4

                                    LLC C D=E0 S=E0 UI
                                    XNS NetWare Request N=174 C=1 T=1
                                    NCP C End of task
47   55  JSH AT       NetWare       DLC AC=10, FC=40, FS=03
                                    LLC C D=E0 S=E0 UI
                                    XNS NetWare Reply N=174 C=1 T=0
                                    NCP R OK
48   58  NetWare      JSH AT        DLC AC=18, FC=40, FS=CF
                                    LLC C D=E0 S=E0 UI
                                    XNS NetWare Request N=175 C=1 T=1
                                    NCP C Get dir path of handle 02
49   72  JSH AT       NetWare       DLC AC=10, FC=40, FS=03
                                    LLC C D=E0 S=E0 UI
                                    XNS NetWare Reply N=175 C=1 T=0
                                    NCP R OK Path=SYS:USR/JSH/MEMO
52   32  Broadcast    JSH AT        DLC AC=18, FC=06, FS=CF
                                    MAC Standby Monitor Present
55   32  Broadcast    JSH AT        DLC AC=18, FC=06, FS=CF
                                    MAC Standby Monitor Present
```

The bytes are shown for a simple directory listing of 10 files. The summary column also shows the encapsulation of each protocol used.

FIGURE 5: *Error-reporting MAC Frame*

```
Sniffer data collected on 5/22/87 at 15:45:24,
file C:\CAPTURE\ATC_TR\4H.TRC, Page 1

- - - - - - - - - - - - - - - - - Frame 1 - - - - - - - - - - - - - - - - -

 Frame Delta t    Destination  Source       Summary
M   1            Error Mon.   NetWare      DLC AC=10, FC=00, FS=03
                                           MAC Report Soft Error

DLC:  ----- DLC Header -----
DLC:
DLC:  Frame 1 arrived at 15:45:27.147; frame size is 48 (0030 hex) bytes.
DLC:  AC: Frame priority 0,  Reservation priority 0,  Monitor count 0
DLC:  FC: MAC frame,  PCF attention code: None
DLC:  FS: Addr recognized indicators: 00, Frame copied indicators: 00
DLC:  Destination: Group address C00000000008, Error Mon.
DLC:  Source      : Station 10005A00F83B, NetWare
DLC:
MAC:  ----- MAC data -----
MAC:
MAC:  MAC Command: Report Soft Error
MAC:  Source: Ring station, Destination: Ring Error Monitor
MAC:  Subvector type: Isolating Error Counts
MAC:             0 line errors,          0 internal errors,       0 burst errors
MAC:             0 AC errors,            0 abort delimiters transmitted
MAC:  Subvector type: Non-Isolating Error Counts
MAC:             0 lost frame errors,    0 receiver congestion,   0 FC errors
MAC:             0 frequency errors,     1 token errors
MAC:  Subvector type: Physical Drop Number 00000000
MAC:  Subvector type: Upstream Neighbor Address 10005A009B38, JSH AT
MAC:

ADDR  HEX                                                  ASCII
0000  10 00 C0 00 00 00 00 08  10 00 5A 00 F8 3B 00 22  ..........Z..;."
0010  60 29 08 2D 00 00 00 00  00 00 08 2E 00 00 00 00  `).-............
0020  01 00 06 0B 00 00 00 00  08 02 10 00 5A 00 9B 38  ............Z..8
```

An error report is sent to a special group address on the ring called the error monitor. The IBM LAN Manager acts as an error monitor when it is present.

create lines for the detail window, to call the protocol interpreters for embedded protocols, and, optionally, to supply new symbolic names discovered within the protocol data.

Protocol interpreters for embedded protocols can be shared because the protocol stacks created by different vendors (such as the seven OSI layers) can share some of the same layers. For example, The Sniffer calls a protocol-interpreter function, written and compiled in Microsoft C. The function is passed a pointer to where the frame data start within the physical frame (the actual bits sent to and received from the physical layer); previously decoded data are skipped. The function's return value is the number of bytes of frame data that were interpreted. The calling interpreter decides whether any subsequent interpreters are to be called, if data remain.

A protocol interpreter is "registered" before it is used. The Sniffer calls another user-written routine that generates a pointer to a structure holding data relevant to the interpreter, such as the name to be included in the protocol selection menu of The Sniffer and the string to be displayed in the detail window.

The Sniffer comes with several library functions to aid the user-written protocol interpreter in displaying appropriate information about the protocol, such as a string of EBCDIC characters or a detailed window-header message, for example, "INTERNET PROTOCOL XYZ FOLLOWS."

Once the custom interpreter is written, it is compiled and then linked with the main Sniffer procedures that form The Sniffer .EXE file ready for execution. It is possible to generate several versions of the .EXE file, each containing only the protocols used for one network. This is handy, because the more protocol interpreters that are resident in memory, the less capture buffer is available.

SNIFFING OUT THE FUTURE

For its sophisticated protocol-interpretation abilities, the portable Sniffer has no competition in the token-ring arena. For Ethernet, several alternatives are available that offer different features and capabilities.

As The Sniffer continues to evolve, it could become superior to many Ethernet analyzers and make it even harder for a competitor to introduce another token-ring analyzer. Before this happens, however, The Sniffer could be improved by the addition of certain features: it should support expanded memory, be able to link-in user-generated protocol interpreters, preserve the capture buffer when moving between capture and display, and offer the more advanced trigger capabilities found in most Ethernet analyzers. As a complete package, The Sniffer might even encourage third-party add-ons, such as a statistical analysis package complete with histograms, or captured data used to feed simulators.

Network General Corporation
1296 B Lawrence Station Road
Sunnyvale, CA 94089
800/232-5599 (G10); 408/734-0464
Sniffer, Ethernet, or Token-Ring configuration, $19,000; dual Ethernet/Token-Ring configuration, $24,000; basic interpreter for physical and data-link protocols included in standard package, interpreters for higher-level protocols, $995 each.

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J. Scott Haugdahl is a senior systems specialist at Architecture Technology Corporation, a consulting, publications, and seminar firm specializing in data communications.

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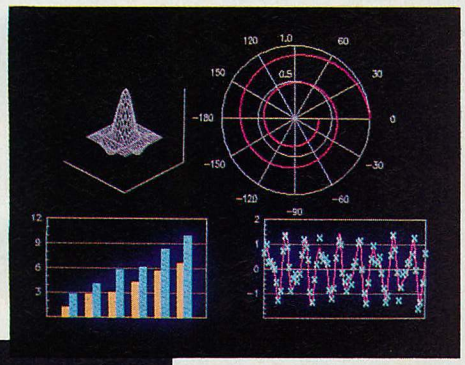
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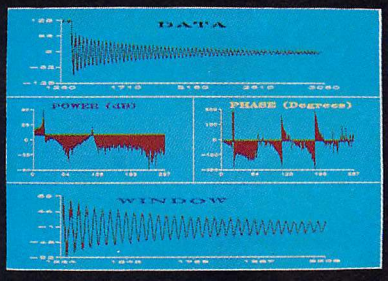
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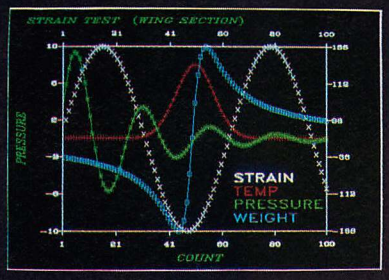
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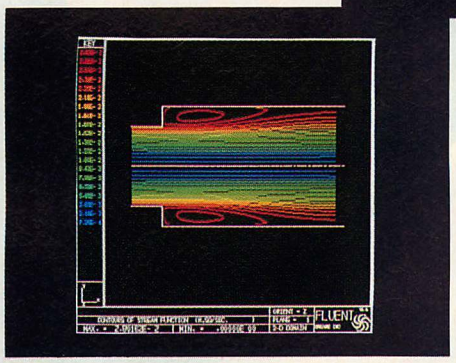
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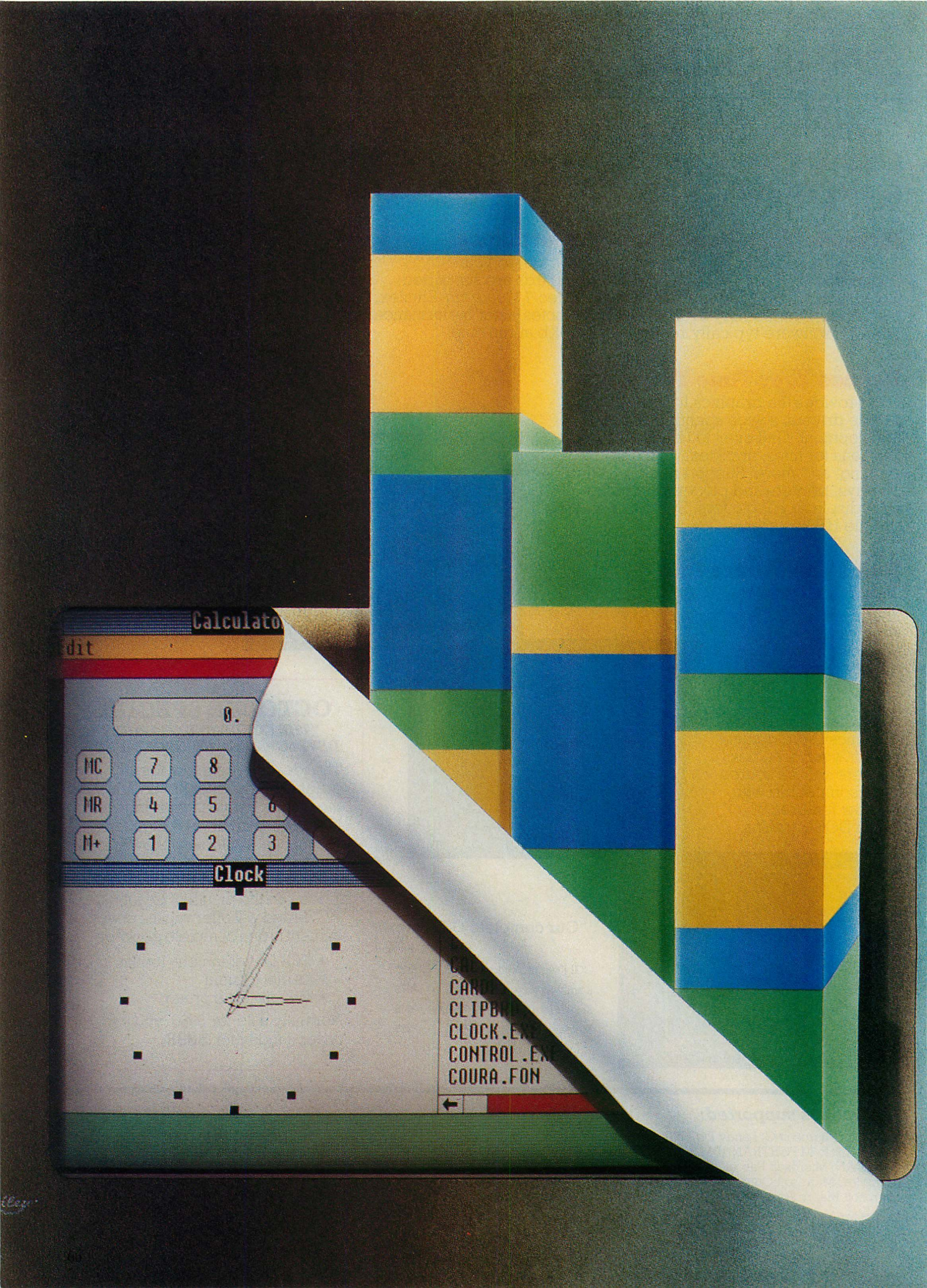
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Windows Memory Management

Behind the curtains, Windows uses sophisticated techniques to manage limited system-memory resources while satisfying the requirements of all active programs in a system.

GUY QUEDENS and STEVEN ARMBRUST

Since the IBM/Microsoft announcement of OS/2 in April of this year, both parties have reinforced their commitment to a Windows-like graphical user interface. Unfortunately, details on the Presentation Manager that provides this interface for OS/2 have been slow in coming. From this perspective, Microsoft Windows serves two purposes: it provides the graphical user interface for the MS-DOS environment; and it can serve as a guideline for developers interested in using the OS/2 Presentation Manager. (For additional information on developing Windows applications for the DOS environment, see "Windows of Opportunity," Paul Grayson, February 1987, p. 70.)

Microsoft has retreated from its original position that Windows applications would port effortlessly to the Presentation Manager. However, most of the concepts of Windows are represented in the Presentation Manager, and software developers who are familiar with these concepts will be positioned to move to the Presentation Manager when it becomes available. Two of these Windows concepts, memory management and device-driver support, are explored in this and the following article ("Windows Virtual Machine," Guy Quedens, p. 90).

ILLUSTRATION • FRANK RILEY

From the end user's point of view, all that is needed to load and execute a new program using Windows' powerful multitasking environment (even if other similar programs are already running) is a simple double-click of a mouse button. Behind the scenes, however, sophisticated memory-management techniques are under way to allocate, organize, and reallocate the system's limited memory resources to satisfy the requirements of all the programs running in the system.

Because of the multitasking nature of Windows, memory management is more complicated than it would be in the single-tasking DOS environment. An ordinary DOS application has access to all available memory in the system. With DOS function requests, an ordinary application can allocate and free areas of memory for its own use, and even set up terminate-and-stay-resident (TSR) programs, blocking that portion of memory from use by future programs. However, because a DOS application assumes that it is the only program running, its memory-management concerns are limited primarily to finding out how much memory is available, gaining access to a block of memory, changing the block size, and releasing the block when finished.

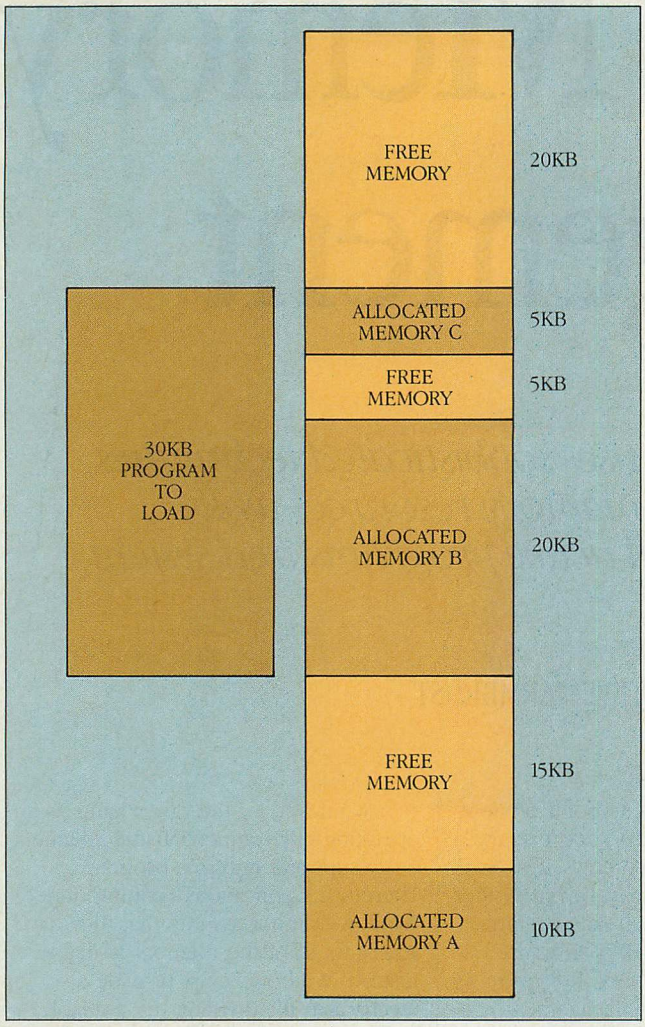
Windows, on the other hand, is an operating environment that simultaneously supports multiple programs. Therefore, applications running under Windows cannot assume that they have access to all of the memory available. Instead, Windows must provide a mechanism for dividing the available memory among all the concurrent processes. The memory management features provided by Windows version 1.04 are examined here; in addition, new functions to be provided with Windows version 2.0 are described.

DYNAMIC STORAGE

The easiest way for a multitasking operating environment to divide central memory among the concurrent processes is to split the memory into fixed blocks and give one to each application. This mechanism must either rely on advanced knowledge about each application's memory usage or apportion the same size block to all applications (often giving them too much or not enough memory).

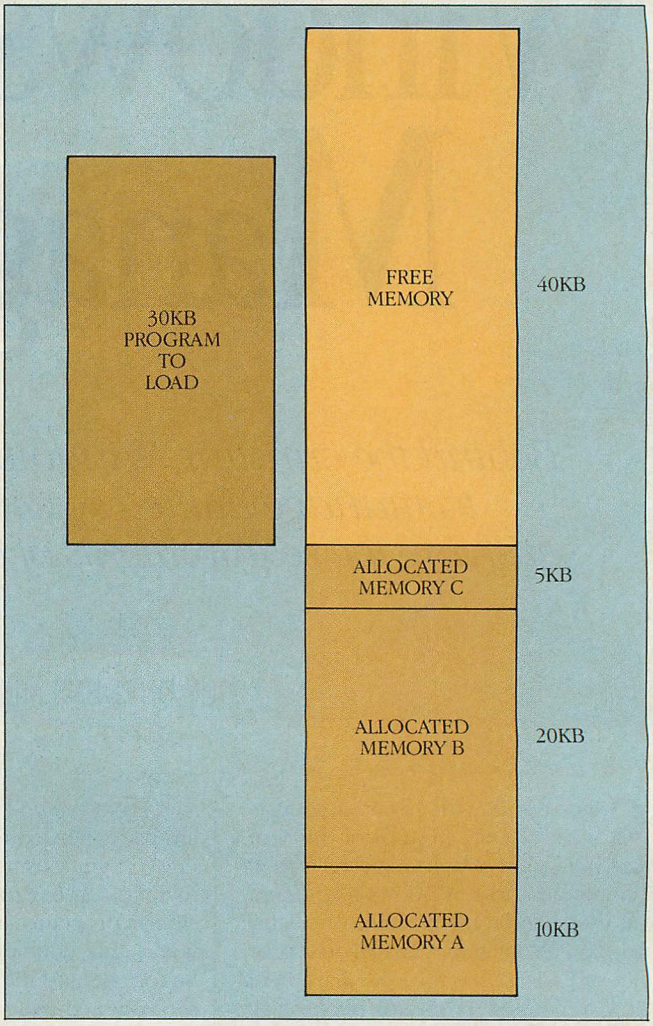
Windows uses a more efficient memory-management scheme in which memory is divided into variable-sized blocks that are dynamically allocated according to the requirements of the tasks being executed. When variable-

FIGURE 1: *Memory Fragmentation*



Free memory is fragmented into several small blocks. Even though 40KB of memory is free, a 30KB program cannot be loaded because no individual free block is large enough.

FIGURE 2: *Memory Compaction*



By reallocating the free blocks to one end of memory, the memory manager makes a contiguous memory block that is large enough to hold the 30KB program.

sized blocks are used, advance selection of block sizes is not necessary. However, the memory manager must keep track of allocated and free memory. Usually, it does so by maintaining a linked list of free memory areas. Windows scans this list when a new block must be allocated and uses a first-fit allocation method to place the block in the first free area that will fit. (Some memory managers use best-fit allocation, which places the block in the smallest free area that will fit). When a block is released, its assigned memory is returned to the free list and combined with any adjacent free areas.

Because variable-sized memory blocks are continually being allocated and freed by the memory manager, system memory can become a hodgepodge of assigned and unassigned memory blocks. *Memory fragmentation* occurs when the available free memory is split into several separate blocks, with each block being too small to be useful. In figure 1, the memory manager needs to assign a 30KB block of memory to a new program, but no single free block larger than 20KB exists. Therefore, even though the system memory has 40KB free, memory fragmentation prevents a 30KB block of memory from being assigned.

One possible solution to fragmentation is *relocation*. To fill an allocation request that is greater than any individual fragment, the memory manager moves the remaining free blocks toward one end of memory, thereby gathering all the available memory together into one contiguous block, as shown in figure 2.

Even though relocation can solve memory fragmentation problems, not enough free memory may be available to satisfy a particular memory-allocation request. In this case, two other techniques can be used: swapping and discarding. *Swapping* makes additional memory available by copying an allocated memory block to a temporary disk file that can be reloaded later when that block is required.

Discarding is similar to swapping, except that the blocks are not copied to disk. Instead, certain blocks that are never modified (such as code segments) are marked as discardable by the memory manager. If the memory manager needs the space occupied by these blocks, it can reuse the memory. The discardable blocks can be reloaded later when they are needed again.

Windows 1.04 supports discarding but does not implement swapping. Both code and data segments are fixed in memory and nondiscardable by default, but they can both be made discardable when allocated.

Relocation, swapping, and discarding techniques can result in more efficient use of memory than is obtained with nonrelocatable blocks. However, the copying of tasks from one location in memory to another can require a substantial amount of time.

WINDOWS MEMORY MODEL

A Windows application has two types of storage available for general purpose usage: global and local. The main distinction between these two types is the amount of memory that can be allocated. Local memory is allocated from the program's heap, which is part of the data segment and, therefore, limited to 64KB bytes. The initial size of the heap is set in the module's link definition file statement

HEAPSIZE bytes

where **bytes** is an integer that specifies the heap size. Because local memory comes from the program's data segment, a local pointer is a 16-bit offset.

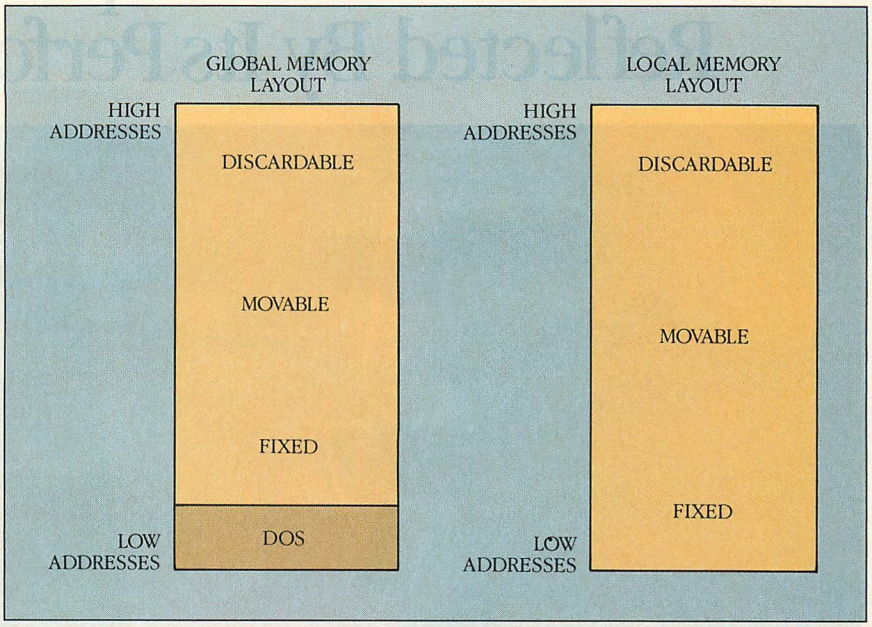
Global memory is all of system memory not allocated to any particular task, usually greater than 64KB. Global addresses are 32-bit pointers.

Both global and local storage may be fixed or movable. Fixed blocks are ones that Windows never moves, even if memory fragmentation occurs. Movable blocks can be rearranged so that fragmented free memory can be combined into a single larger block. Movable storage can also be classified as discardable. This means that if Windows receives a memory-allocation request from the active application and some of an inactive application's memory blocks are declared as discardable, Windows can assign those blocks for use by the active application. When the inactive application becomes active, either Windows or the application itself must reread those blocks into memory.

Figure 3 illustrates the relative placement of fixed, movable, and discardable allocations within global and local blocks. Fixed allocations are placed lower in memory to thwart the development of road blocks in which free memory blocks are trapped on either side of a fixed block and cannot be combined.

An area of memory allocated from local or global memory is called an object (either a local object or a global object). A program's code and data segments are separate objects allocated from global memory. Thus, each program's local memory, which is part of the data segment, is actually part of an object allocated from global memory.

FIGURE 3: *Placement of Memory Items*



Fixed memory items are stored lower in both global and local memory to avoid trapping free memory blocks on either side of a fixed memory block.

Figure 4 illustrates the relationship between global and local memory. Note that even though a local object can be fixed, the entire segment containing local memory might be a movable global object. In such a case, the local fixed object remains relatively fixed within the local segment, but it still could be moved with the rest of the global object.

Code segments can be marked discardable. This means they can be reread from disk. Windows automatically rereads a discarded code segment when some user activity, such as clicking the mouse in the window, causes the application to become active.

Windows scans memory on a first-fit basis from low to high to satisfy a request for a fixed block allocation (or from high to low for a movable block). If no free block is large enough to meet the memory request, Windows moves blocks to make a larger contiguous block. The movement continues until the request is met or until no more blocks can be moved.

If the memory request still cannot be satisfied, Windows starts discarding blocks that are marked as discardable. It maintains a least-recently-used chain of discardable blocks to determine which blocks it is to discard first. Windows continues discarding blocks until no more are left to discard or until the allocation has been met. If the allocation still cannot be made, Windows returns an error code.

MEMORY ALLOCATION

Whenever a program needs a global or local block of memory, it invokes a Windows function in order to allocate that memory for its own use. In response, Windows reserves the block of memory and returns a 16-bit unsigned integer. This value, which is called a *handle*, can always be used to find out information about the block. Handles are necessary because Windows frequently moves and discards blocks. A block's memory addresses might not remain constant, but a program can always discover where the block is currently located by using its handle as input to a Windows function.

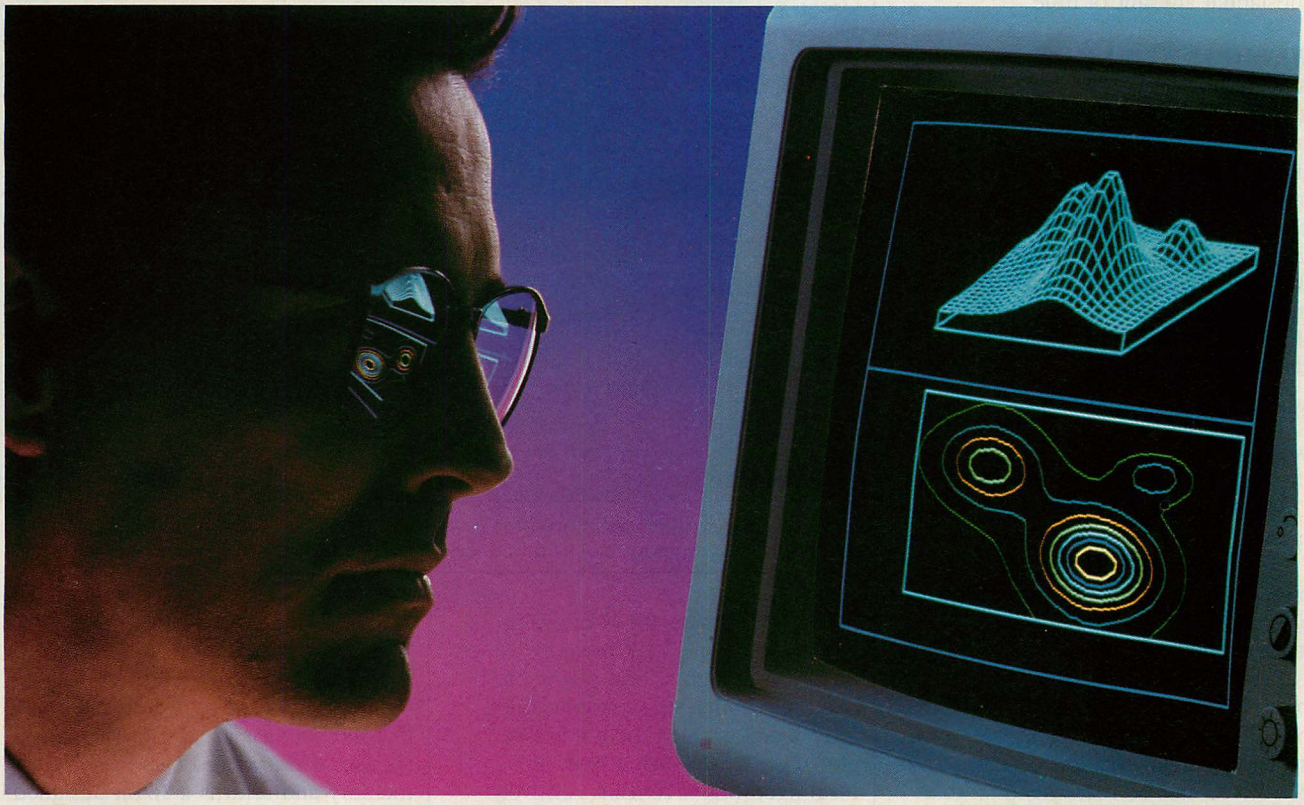
Operations on global or local memory are performed with similar functions. All functions relating to global memory begin with **Global**; most local memory functions begin with **Local**. A program makes a formal request for storage allocation via one of these two functions:

GlobalAlloc (wFlags, dwBytes) : hMem
LocalAlloc (wFlags, wBytes) : hMem

If Windows can allocate the requested memory, it returns **hMem**, a nonzero value that is a handle to the memory. If NULL is returned, the allocation has failed.

The unsigned short integer (or word) **wFlags** specifies exactly what type of allocation is desired. Its value can take on any of the following attributes (they can also be ORed together

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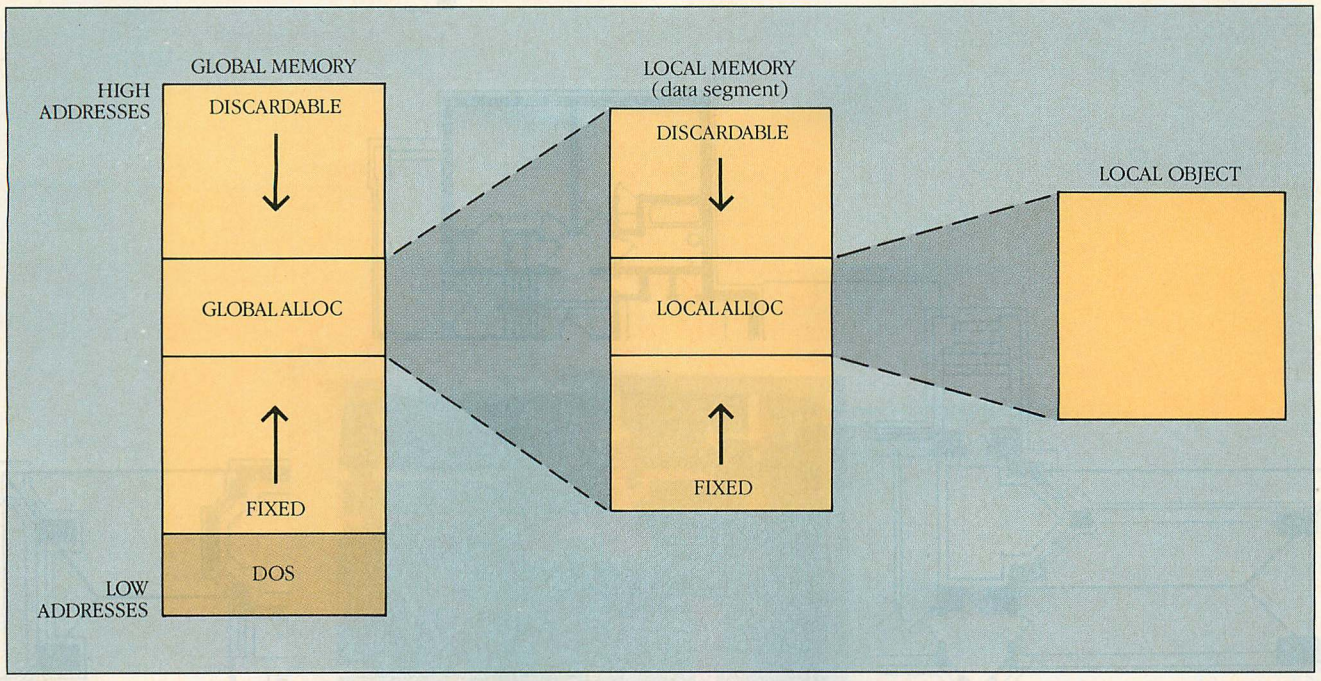
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FIGURE 4: *Windows Memory Map*



The data segment, which contains all of local memory, is allocated from global memory. Even though a local object can be fixed, the entire segment containing local memory might be a movable global object. LocalAlloc allocates local memory.

to combine the attributes when the combination seems to make sense):

FIXED:	memory is fixed
MOVEABLE:	memory is movable
ZEROINIT:	memory is initialized to zero
DISCARDABLE:	memory is discardable
NOCOMPACT:	moving and discarding will not be performed to satisfy the allocation

Either **dwBytes** (a 32-bit value) or **wBytes** (a 16-bit value) indicates the size of the memory request. Windows allocates an additional 16 bytes, called the *arena header*, at the beginning of the memory block. The arena header keeps track of the block's attributes as well as its parameters.

Once a memory block has been allocated, a program can change the block's size or type by using one of the reallocation functions. Furthermore, if a block has been discarded, the reallocation functions can be used to recover that memory for reloading the block. The reallocation functions are

```
GlobalReAlloc (hMem, dwBytes, wFlags) :
  hNewMem
LocalReAlloc (hMem, wBytes, wFlags) :
  hNewMem
```

These functions work much like the allocation functions. The only significant difference is that the program also passes **hMem**, the handle of the block to be reallocated.

For example, suppose that a program used the **GlobalAlloc** function to allocate a certain amount of fixed memory. The program now wishes to increase the amount of memory that is present in the block to **dwBytes**, change the block to be movable, and initialize the new bytes to zero. The following call

```
hMem = GlobalReAlloc (hMem, dwBytes,
          GMEM_MOVEABLE
          GMEM_ZEROINIT);
```

performs all these operations.

ACCESSING MEMORY

Usually, a program must call other Windows functions after it gets a handle for a memory block and before it can read or write the memory. Only handles that represent local fixed blocks of memory can be used directly as pointers. Local handles are 16-bit offsets and, therefore, are sufficient to identify a local block. In addition, fixed blocks are not moved by Windows, so the addresses remain valid. Accessing a local fixed block can be accomplished with the following code:

```
char     *LocMemPtr;
if (LocMemPtr = (char *) LocalAlloc
  (wBytes, LMEM_FIXED))
*LocMemPtr = 'Q';
```

In this example, if **LocalAlloc** returns a handle (not NULL and, thus, TRUE), the constant 'Q' will be assigned to the location specified by the handle. Note that this works only for local fixed handles.

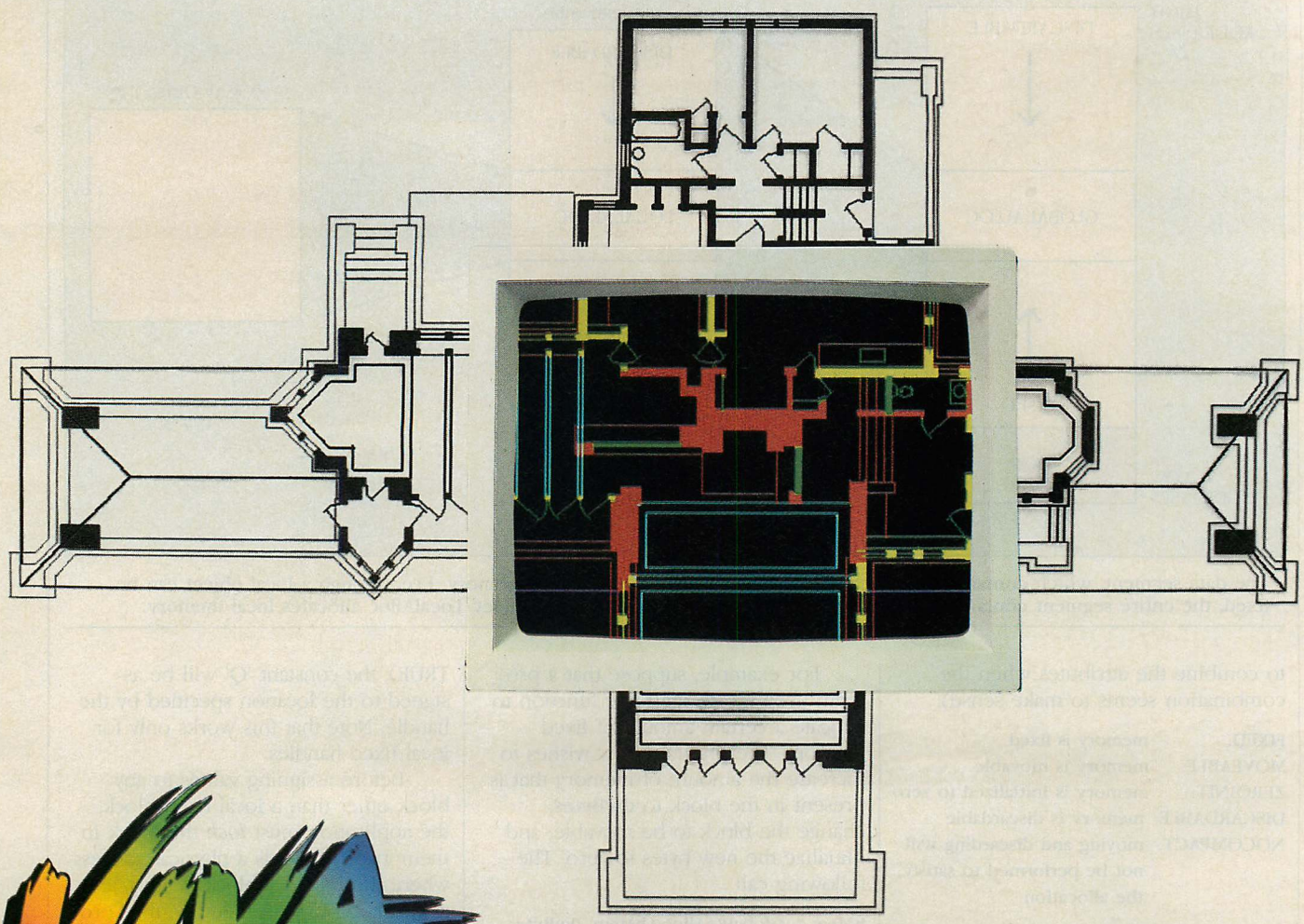
Before assigning values to any block other than a local fixed block, the application must *lock* the block in memory. This yields a physical address where the memory block resides, and it fixes the block in memory, thus protecting it from being moved or discarded. The locking functions are

```
GlobalLock (hMem) : lpAddress
LocalLock (hMem) : pAddress
```

If the block of memory identified by the handle is present in memory, Windows locks the memory into place and returns the address to it. **GlobalLock** generates a 32-bit physical address. **LocalLock** generates a 16-bit physical offset. If either of these functions returns a NULL, the specified block has been discarded. In this case, the application must call **GlobalReAlloc** or **LocalReAlloc**, using the same handle as input, in order to reallocate the memory for that block. Windows then will load the block from disk automatically when a program attempts to access the data contained in that block.

Once a program locks a memory block, it can use the address returned for reading and writing the block. An application can also pass the address to another application in order to share

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the memory block. Before the program returns control to Windows, it should unlock the memory again, this time using the following functions:

```
GlobalUnlock (hMem) : bResult
LocalUnlock (hMem) : bResult
```

bResult returns the Boolean value TRUE or FALSE on success or failure.

The following is an example of locking a global handle:

```
HANDLE     hGlobal;
char*GlobalPtr;
hGlobal = GlobalAlloc ( . . . )
GlobalPtr = GlobalLock (hGlobal);
*GlobalPtr = . . .
GlobalUnlock (hGlobal);
```

A memory block is not limited to a single level of locking. If multiple routines or applications have access to the same block, they each might want to lock the memory to gain access to it, especially if each is an independent process. Windows keeps track of memory locking by using a field within the arena header called the *lock count*. Calling a locking function causes the lock count to be incremented; calling an unlocking function causes the lock count to be decremented. A block is not unlocked until its lock count is decremented to zero.

Local and global memory are not the only kinds of memory subject to movement. By default, the data segment (a global object) is created as a fixed block. This can be overridden in the module definition file using the statement **DATA MOVEABLE**.

If an application has a movable data segment and it wants to fix the segment memory, it can use the following two functions:

```
LockData (Dummy) : hMem
UnlockData (Dummy)
```

Windows returns **hMem**, a handle to the data segment. It can be used as input to other global memory management functions (such as **GlobalLock**, to get the full 32-bit address of the data segment). **Dummy** is not used and can be set to zero; in fact, its declaration can even be omitted. The reason **Dummy** is there at all has to do with how the **LockData** and **UnlockData** functions are defined in terms of the more general **LockSegment** and **UnlockSegment** functions added in Windows version 1.03. The format of these functions is as follows:

```
LockSegment (wSegment) : hMem
UnlockSegment (wSegment) : hMem
```

These functions lock or unlock the segment specified by the address **wSegment**; the segment handle is returned. If **wSegment** is −1 (FFFFH), the current data segment is locked/unlocked. **LockData** and **UnlockData** are now defined in terms of the new **LockSegment** and **UnlockSegment** functions, as shown by the following relationships found in WINDOWS.H definitions file provided with the Microsoft Windows Software Development Kit:

If an application does not need all of its allocated memory, it should either free the memory or allow it to be discarded.

```
#define LockData
  (dummy) .   LockSegment (0xFFFF)
#define UnlockData
  (dummy)   UnlockSegment (0xFFFF)
```

These define statements convert any call to **LockData** or **UnlockData** to an equivalent call to **LockSegment** or **UnlockSegment** with an argument of 1. These definitions are the reason that dummy parameters are required with **LockData** and **UnlockData**.

Two situations are possible that need **LockData** and **UnlockData** (or **LockSegment** and **UnlockSegment**). First, when an application calls the functions **GetMessage** or **PeekMessage** (which enable other applications to run), Windows decrements the data segment's lock count, thereby allowing the segment to move about while other applications are running. Returning from these functions causes the lock count to be incremented.

Second, the function **LocalAlloc** also can cause the data segment's lock count to decremented to 0. This happens when the request for local memory requires Windows to expand the local heap, which could require moving the segment to provide the additional contiguous memory required. In this case, Windows decrements the lock count so that it can move the segment.

These conditions imply that 32-bit pointers are invalidated when a program calls **GetMessage**, **PeekMessage**, or **LocalAlloc**. Thus, programs must either lock down the data segment before calling those functions or reestablish their outstanding 32-bit pointers (by calling **GlobalReAlloc** using the data segment's handle as input) after the functions return.

If an application requests a larger local block than is immediately available, Windows tries to *compact* the local heap by moving and discarding. If the heap does not need compacting, these functions are provided:

```
LocalFreeze (Dummy)
LocalMelt (Dummy)
```

Again, **Dummy** is not used and can be set to zero.

Because **LocalFreeze** stops Windows from rearranging local memory, **LocalFreeze** and **LocalMelt** can be used to gain access to local movable objects:

```
char**LocMemPtr;
LocMemPtr = (char **) LocalAlloc
  (wBytes, LMEM_MOVEABLE)
LocalFreeze (0);
**LocMemPtr = 'Q';
LocalMelt (0);
```

Although this method works, **LocalLock** and **LocalUnlock** can be used instead to gain access to local data, as follows:

```
char*LocMemPtr;
HANDLE     hLocMem;
hLocMem = LocalAlloc (wBytes,
  LMEM_MOVEABLE)
LocMemPtr = LocalLock (hLocMem);
*LocMemPtr = 'Q';
LocalUnlock (hLocMem);
```

In fact, Microsoft prefers the latter method to gain such access.

FREEING AND COMPACTING

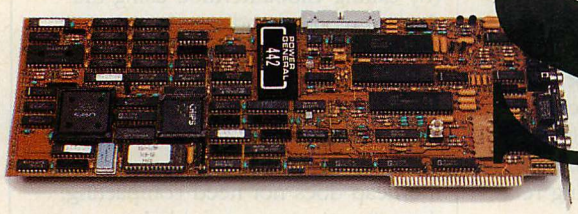
The concepts of freeing and discarding memory are closely related. To free a memory block is to relinquish both the block and its associated handle. When freed, a block's handle is no longer valid as input to the Windows memory-management functions.

To discard a memory block means that the memory allocated to a handle no longer exists, but the handle is still valid. Memory can be provided for a discarded block by presenting its handle to **GlobalReAlloc** or **LocalReAlloc**.

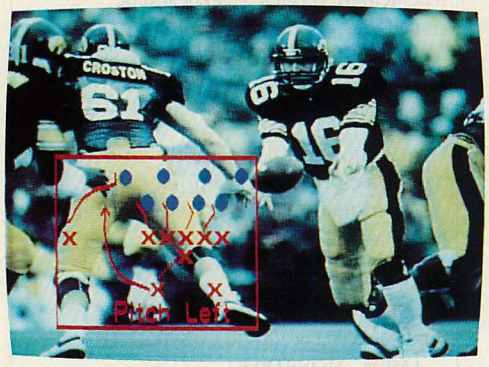
Freeing and discarding memory are important in a cooperative environment such as Windows. If an application does not need all of its allocated memory, it should either free or discard it. The freeing functions are

```
GlobalFree (hMem) : hOldMem
LocalFree (hMem) : hOldMem
```

where **hMem** is the handle issued by the allocate or reallocate function. If



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the function is successful, **hOldMem** is NULL; otherwise, it is equal to **hMem**.

Applications should free any global memory allocated to them before program termination. This is not strictly required—Windows will deallocate the global memory of a terminated program—but it promotes good programming practices. Although applications should free local memory when it is no longer needed, local memory is part of the data segment, which Windows will free automatically when the application terminates.

During the memory allocation process, Windows will automatically dispose of discardable blocks if it needs the memory used by those blocks. An application can discard a block by using one of the discarding functions:

GlobalDiscard (hMem) : hOldMem
LocalDiscard (hMem) : hOldMem

As is the case with the freeing functions, **hMem** is a memory handle for the block that is to be discarded. Windows sets **hOldMem** to NULL if the function is successful; otherwise, **hOldMem** is set to **hMem**.

The discard functions mark the block as discardable and may or may not actually discard it. The next time the block is locked determines whether or not it is still valid.

As described earlier, Windows will compact memory if it cannot satisfy a memory request by using the first-fit technique. In addition, an application can call compaction functions. These compaction functions are informational but, if necessary, they might cause Windows to compact as well. The compaction functions are as follows:

GlobalCompact (dwMinFree) : dwLargest
LocalCompact (wMinFree) : wLargest

MinFree is the argument of the question: "Are **MinFree** bytes available?" Windows returns the answer: "**Largest** is the largest number of bytes available." If **MinFree** is larger than any available block, Windows will compact memory until it makes available a block at least that large—if possible. Then it will return the size of that block. If **MinFree** is NULL, Windows will return the size of the largest available block, but it will not actually compact memory. Therefore, **Largest** might not be the largest block that could be generated by moving and discarding. To force Windows to compact all of memory, **MinFree** can be specified as −1 (the largest possible value). Memory compaction can be rather complicated, particularly if applications lock global memory objects for less than minimal amounts of time.

SIZE, FLAG, AND NOTIFY

In addition to the previous memory-management functions, Windows provides several miscellaneous functions.

The two size functions listed below return the current size of a specified memory block:

GlobalSize (hMem) : dwBytes
LocalSize (hMem) : wBytes

The following two functions return a handle for a memory object whose address is known:

GlobalHandle (wMem) : dwMem
LocalHandle (wMem) : hMem

The parameter **wMem** specifies a storage address: either segment for global memory or offset for local memory.

According to Microsoft, software that meets the Lotus/Intel/Microsoft EMS version 4.0 will be able to work with Windows 2.0.

The handle for the memory object is returned. In the **Global** function, the high-order word contains the segment.

Windows also has two flag functions that return status information about a specified memory block:

GlobalFlags (hMem) : wFlags
LocalFlags (hMem) : wFlags

wFlags is a word with a low byte that contains the current lock count and a high byte that contains flags indicating the functions SWAPPED, DISCARDED, and DISCARDABLE. These functions can be used to determine whether a discardable block is still present in memory, or whether it has been discarded and now must be reloaded. Although the SWAPPED value is described in Microsoft's documentation, Windows does not currently support swapping.

Finally, the following Windows function sets the address of a procedure that will be called in the event of a local heap exception:

LocalNotify (lpNotifyFunc) : lpPrevFunc

in which **lpNotifyFunc** is that particular address. The address of the previous handler is returned.

The procedure specified by **lpNotifyFunc** is called the *local heap notification handler*. This procedure receives one of the following messages when the corresponding event occurs:

LNOTIFY_OUTOFMEM
LNOTIFY_MOVE
LNOTIFY_DISCARD

As are all procedures that Windows calls, **NotifyFunc** must use the Pascal calling convention. Furthermore, it must accept three arguments

```
BOOL FAR PASCAL NotifyFunc (wMsg,
  hMem, wArg)
WORDwMsg;
HANDLE      hMem;
WORDwArg;
```

where **wMsg** is one of the three messages listed above; **hMem** is the handle of the memory object that caused the notification generation; and **wArg** is a word parameter that depends on **wMsg**. A Boolean value is returned indicating success or failure.

There are some restrictions placed on the functions that the local heap notification handler is allowed to call. In general, this procedure can call local memory management functions as long as the functions do not move local data or allocate new data. The procedure can call **LocalLock**, but it cannot call **LocalReAlloc**.

DEFINING AND TESTING

In addition to using the functions outlined here, Windows applications can use the C runtime functions **calloc**, **malloc**, **realloc**, and **free** in all memory models. The file WINDOWS.H contains definitions for these functions that associate them with the Windows local memory functions as follows:

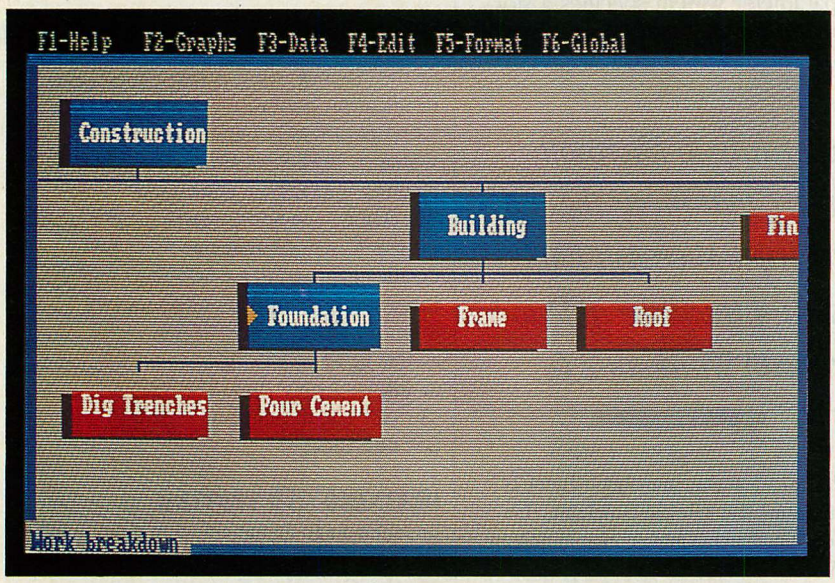
```
#define calloc (n,size)   LocalAlloc
                          (LMEM_ZEROINIT,
                          n*size)
#define malloc (size)     LocalAlloc (0, size)
#define free (p)          LocalFree (p)
#define realloc(p, size)  LocalReAlloc (p, size,
                          LMEM_ZEROINIT)
```

Therefore, whenever a program calls one of the C runtime functions, the corresponding Windows local function also will be called.

Testing a Windows application in a movable memory environment presents a unique set of problems because there is no way to duplicate every possible situation with which the memory manager will be faced. However, Microsoft provides two test programs with the Windows Software Development Kit:

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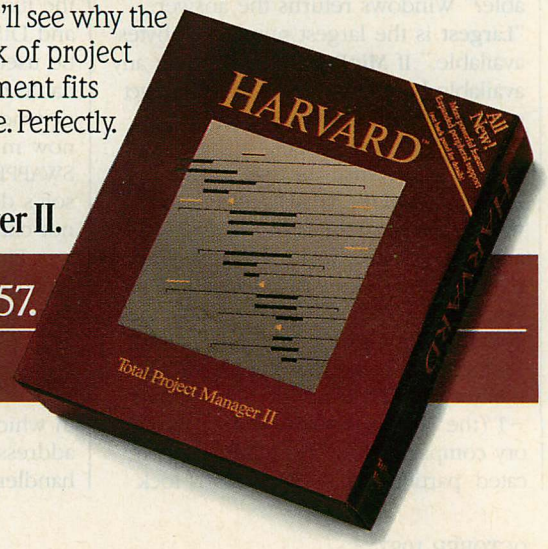
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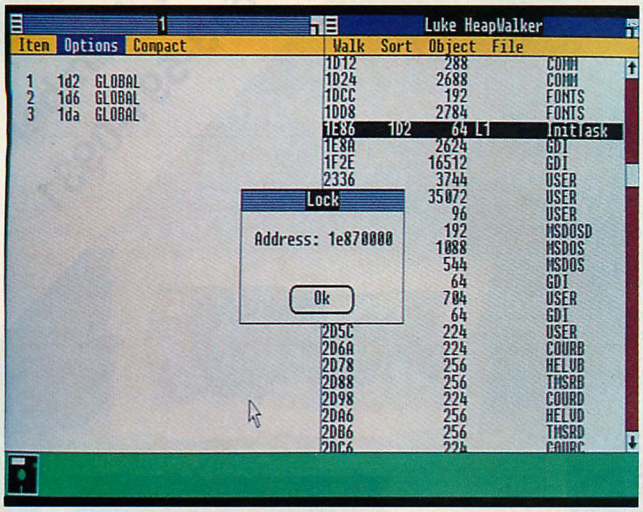
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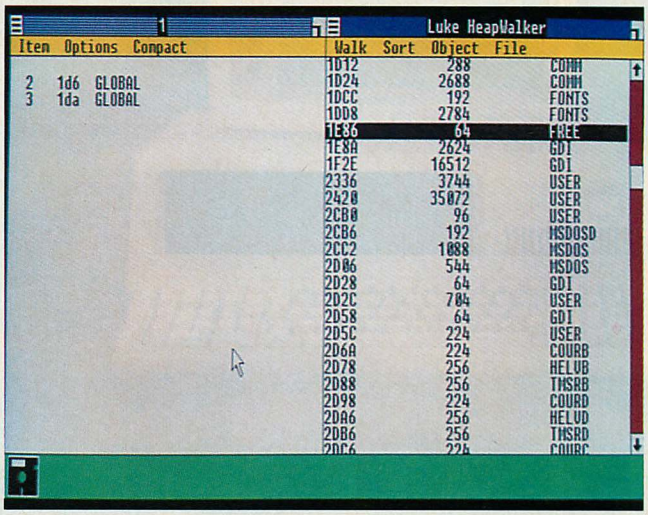
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PHOTO 1: *Global Memory Allocation*



MEMMGR allocates and then locks a block of global memory. This is reflected in the HEAPWALKER window.

PHOTO 2: *Freeing Memory*



MEMMGR frees the first block of global memory allocated. Verification is provided using the HEAPWALKER window.

SHAKER and HEAPWALKER. SHAKER is designed to test an application in the movable memory environment. It runs concurrently with other applications, allocating and deallocating blocks of random sizes, thereby forcing other applications to move about in the available memory. HEAPWALKER permits viewing the global and local heaps, so users can see how their applications are being moved around by SHAKER.

SHAKER and HEAPWALKER should be implemented as part of the applications development process. If an application can continue to function with these two test programs jogging the system memory, then the developer can feel fairly confident that the application will be able to survive out in the field with other Windows applications.

LOOKING TO THE FUTURE

Windows 2.0, announced by Microsoft in April for delivery in the third quarter of 1987, will remain compatible with version 1.04 in terms of memory management. Additionally, two new wire functions are to be added:

GlobalWire (hMem) : lpAddress
GlobalUnwire (hMem) : void

Microsoft uses the term *wire* to mean "move a memory block to low memory and lock it down." Wiring a block is desirable when an application wishes to lock the block for an extended period of time. In these special circumstances, moving the memory to low memory before locking it minimizes the fragmentation problems. In ordinary situations, a Windows application will not need to lock memory for an extended period of time. Therefore, the lock and unlock functions can take care of the job.

Windows 2.0 will manage a system's expanded memory, if the installed expanded memory manager software is designed for use with Windows. According to Microsoft, software that meets the Lotus/Intel/Microsoft Expanded Memory Specification (LIM EMS) version 4.0 will work with Windows 2.0. The new version of Windows can use expanded memory as an allocatable system resource to support the execution of multiple applications in preference to the time-consuming process of relocating, discarding, and reloading memory objects.

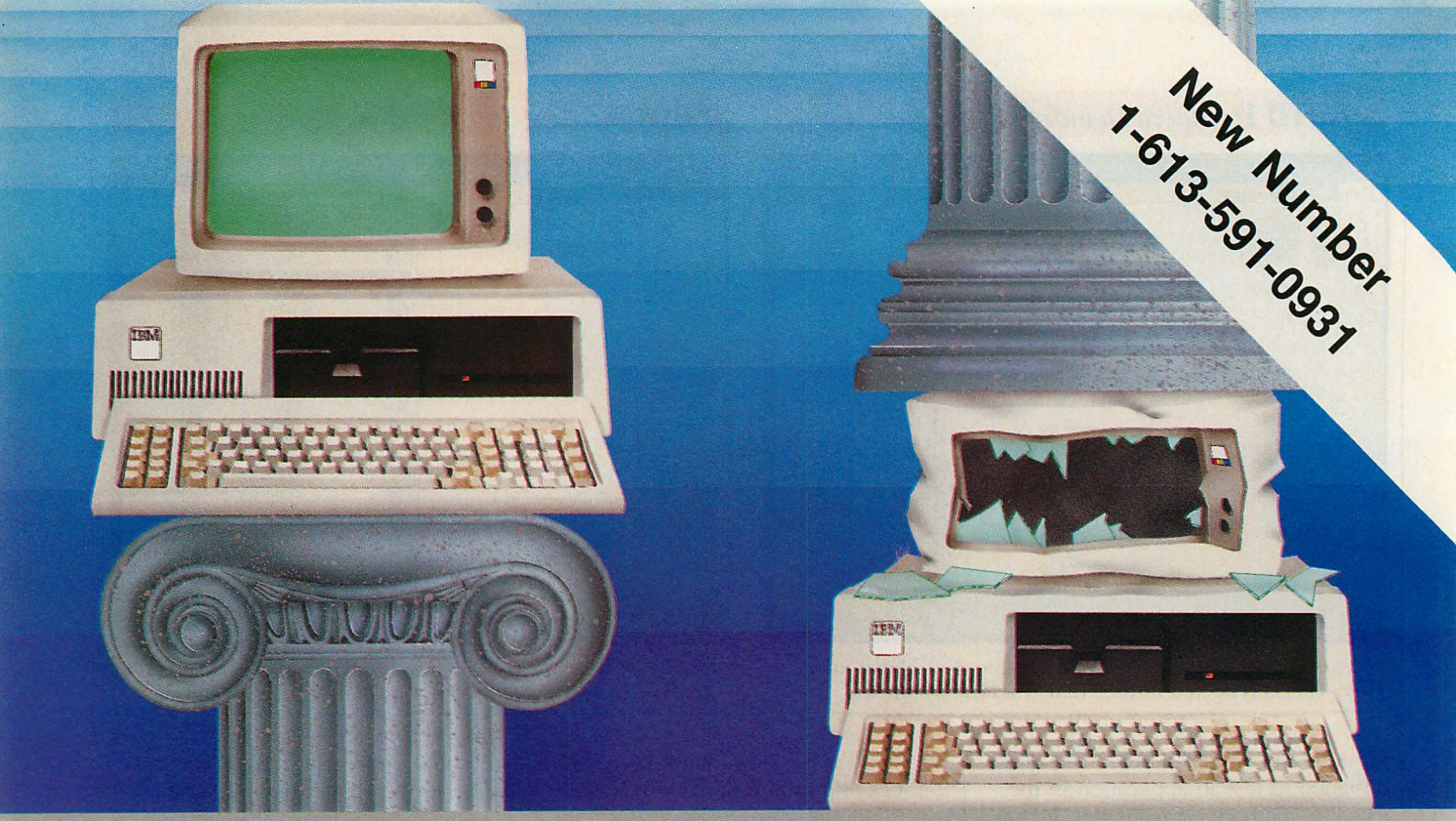
If a Windows-compatible expanded-memory manager is installed, Windows 2.0 will create a "window" into expanded memory using available portions of the 1MB address space above Windows itself. It will then use this window to load an application and, if possible, its data into expanded memory. When it loads the next application, Windows will remap the window to a different portion of expanded memory, and load the application.

In this way, multiple applications can be loaded up to the total size of the expanded memory available for use by Windows. If the window into expanded memory is large enough to accommodate an entire application, then Windows only has to remap the window to the portion of expanded memory reserved for that application when control is given to the application. Relocation, discarding, and reloading of memory blocks is avoided entirely, and the whole process is transparent to the application. The size of the window into expanded memory, of course, depends on the particular EMS board and its software, and the amount and location of the system's conventional and adapter memory.

If the window into expanded memory is not large enough to accommodate an entire application, Windows 2.0 will store as much of its code and data as will fit in the window into expanded memory. The remainder of the application will be stored in conventional memory and managed using the usual relocation and discarding techniques. This latter strategy is likewise used when the expanded memory becomes filled with applications.

Currently, individual Windows applications can use expanded memory directly; they also will be able to do so under Windows 2.0 with certain restrictions. When such an application is linked for use with Windows 2.0, a switch must be set to indicate that it will use expanded memory directly. When such an application is running, Windows 2.0 cannot use the application's expanded memory window, but it can store other applications into the remaining expanded memory that is available to Windows.

Windows 2.0 will include a hard-disk caching program called SMARTDrive, which promises to speed up the reloading of code from disk as well as normal disk reads. This program uses a memory buffer in order to improve disk-read performance. The buffer may be located in either expanded or extended memory.



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The SMARTDrive program is specified as a device in the CONFIG.SYS file and runs in base memory. Because the program works more efficiently using expanded memory, Microsoft recommends that as much expanded memory as possible be reserved for SMARTDrive (and for Windows 2.0). Unlike some other disk-caching programs, SMARTDrive is designed to work cooperatively with Windows. SMARTDrive will have the ability to reduce the size of its expanded memory allocation dynamically in order to provide the additional expanded memory that is required by Windows 2.0.

PRACTICAL EXAMPLES

The accompanying listings contain a program that allows the user to use the Windows memory-management function calls and immediately see their effect. The program, MEMMGR.C, shown in listing 1, lets the user allocate 16 different blocks and use the memory-management function calls to manipulate those blocks. As each allocation is made, the display reflects the current allocation status. The title bar contains the number of the currently selected *item*, or memory allocation, and can be changed via the Item menu option.

Once one of the sixteen items is selected, the Options pop-up menu allows operation on that item, performing functions such as **Allocate**, **Lock**, or **Free**. The pop-up menu item Allocate will be replaced with ReAllocate if the particular item is already allocated. Each of the Options menu items corresponds directly to a Windows memory-management function.

The third menu item is Compact. The Compact option on the Options menu exercises the **GlobalCompact** and **LocalCompact** functions. When using these functions, pay close attention to what is happening in memory by using Microsoft's HEAPWALKER program. Note that the segments are moving and being discarded.

This relatively simple application was designed as a learning aid and not as a full-blown application. Therefore, care should be exercised with respect to following the memory-management rules. Some rules are enforced, others are not. For example, this program will allow an attempt to free an allocation before it is unlocked, which clearly can be avoided using software checks.

The other four listings that comprise the sample application include: MEMMGR.DEF (listing 2), the link definition file used with this application; MEMMGR.H (listing 3), the header file; MEMMGR.RC (listing 4), the program's resource description file; and MEMMGR (listing 5), the program's Make instructions. MEMMGR.EXE, the executable code, is available on PCTECHline and can be generated from the listing files by invoking the command:

```
MAKE MEMMGR
```

For a greater appreciation of this program, the user should concurrently run HEAPWALKER. Photo 1 illustrates locking of a global memory allocation that is reflected in the HEAPWALKER window. Remember, the arena header takes 16 bytes; the physical address occurs one paragraph later. Photo 2 illustrates the effect of freeing the memory.

POWERFUL AND EFFECTIVE

Windows memory-management functions allow application programs to use available storage resources effectively. The Windows memory manager enables Windows to apportion system memory to concurrently running programs. These functions are more complex than the equivalent DOS functions, but the extra complexity is required to enable Windows to allocate memory resources dynamically and efficiently.

Along with this increased functionality comes increased responsibility. The Windows environment is a nonpreemptive cooperative system, in which each application must wisely manage its own resources. Just as voluntarily giving up control of the CPU is important for overall performance of the system, unlocking memory before relinquishing the CPU and freeing and discarding memory when it is no longer needed are also important considerations. Windows applications have the power to deal with large amounts of memory in an environment shared with other applications, but they are obliged to play by the rules.

Guy Quedens is a systems software engineer with Xerox Corporation. Steven Armbrust is a freelance technical writer.

LISTING 1: MEMMGR.C

```
/*****************************************************************/
/* Filename:     MEMMGR.C                                        */
/*                                                               */
/* Description:  Program source                                  */
/*---------------------------------------------------------------*/

#include "windows.h"
#include "memmgr.h"

typedef BOOL FAR * LPBOOL;

  HANDLE              hInst;
  FARPROC             lpAllocProc;
  int                 i,              index;
  char                szString[80],   szNumber[17],   szStr[4];
  HMENU               hMenu;
  HANDLE              hOldMem;
  unsigned int        flags;

struct {
  HANDLE              hMem;           /* handle to memory block  */
  unsigned int        flags;          /* allocation flags        */
  BOOL                colour;         /* T: Global  F: Local     */
  unsigned int        size;           /* block size              */
  } memory[16];

  unsigned int        item            = 0;    /* current item */
  BOOL                bValOK;
  BOOL                bLocalFreeze    = FALSE;
  BOOL                bLockData       = FALSE;
/*===============================================================*/

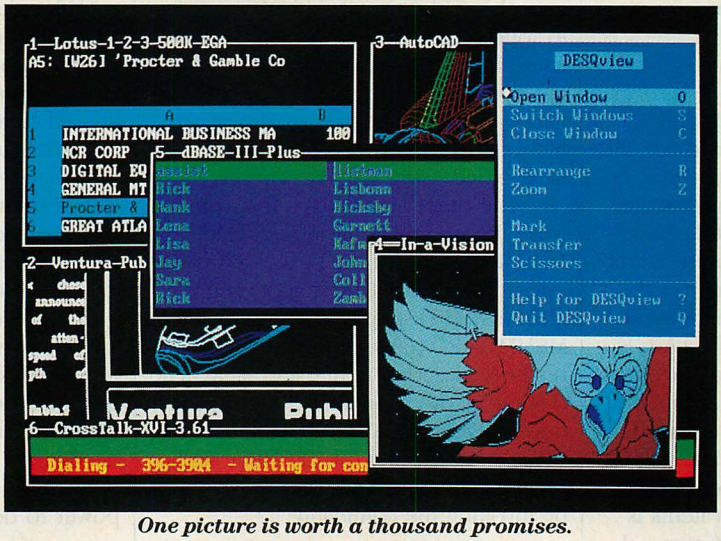
long FAR PASCAL MainWndProc (hWnd, msg, wParam, lParam)
  HWND          hWnd;
  unsigned      msg;
  WORD          wParam;
  LONG          lParam;
  {
  PAINTSTRUCT   ps;
  int           lineNum;

  switch (msg) {
    case WM_CREATE:
      hMenu = GetMenu (hWnd);
      EnableMenuItem (hMenu, IDLOCALMELT, MF_GRAYED);
      EnableMenuItem (hMenu, IDUNLOCKDATA, MF_GRAYED);
      break;

    case WM_DESTROY:
      for (i=0; i<16; i++)              /* Free any allocations */
        if (memory[i].hMem)
          if (memory[i].colour)
            GlobalFree (memory[i].hMem);
          else
            LocalFree (memory[i].hMem);
      PostQuitMessage (0);
```

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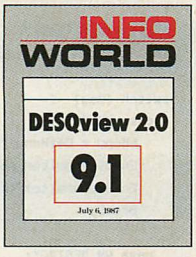
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```
        break;

      case WM_PAINT:
        BeginPaint (hWnd, (LPPAINTSTRUCT)&ps);
        for (i=0, lineNum = 2; i<16; i++) {
          if (memory[i].hMem) {
            itoa (i+1, szNumber, 10);
            index = StrCopy (szString, 0, szNumber, 2, TRUE);
            index = StrCopy (szString, index, "  ", 2, FALSE);
            itoa (memory[i].hMem, szNumber, 16);
            index = StrCopy (szString, index, szNumber, 4, TRUE);
            index = StrCopy(szString, index, (memory[i].colour)
                        ? ("  GLOBAL  ") : ("  LOCAL   "), 10, FALSE);
            TextOut (ps.hdc, 8, lineNum += 12, (LPSTR)szString, index);
            }
          }
        EndPaint (hWnd, (LPPAINTSTRUCT)&ps);
        break;

      case WM_INITMENU:
        hMenu = GetMenu (hWnd);
        CheckMenuItem (hMenu, item + IDITEM01, MF_CHECKED);
        if (memory[item].hMem)
          ChangeMenu (hMenu, IDALLOCATE, (LPSTR)"ReAllocate",
                  IDALLOCATE, MF_CHANGE | MF_BYCOMMAND);
        else                                    /* here if item free */
          ChangeMenu (hMenu, IDALLOCATE, (LPSTR)"Allocate",
                  IDALLOCATE, MF_CHANGE | MF_BYCOMMAND);
        break;

      case WM_COMMAND:
        MainWndWMCommand (hWnd, msg, wParam, lParam);
        break;
      default:
        return DefWindowProc (hWnd, msg, wParam, lParam);
        break;
      }
    return (0L);
    }

MainWndWMCommand (hWnd, msg, wParam, lParam)
  HWND          hWnd;
  unsigned      msg;
  WORD          wParam;
  LONG          lParam;
  {
  if ((wParam >= IDITEM01)
   && (wParam <= IDITEM16)) {
    hMenu = GetMenu (hWnd);
  CheckMenuItem (hMenu, item + IDITEM01, MF_UNCHECKED);
  CheckMenuItem (hMenu, wParam, MF_CHECKED);
  item = wParam - IDITEM01;
  itoa (item+1, szStr, 10);
  SetWindowText (hWnd, (LPSTR)szStr);
  }
else {
  switch (wParam) {
    case IDALLOCATE:
      if (DialogBox(hInst, MAKEINTRESOURCE(MEMDLGBOX),
                                        hWnd, lpAllocProc))
        InvalidateRect (hWnd, (LPRECT)NULL, TRUE);
      break;


    case IDFREE:
      if (memory[item].hMem) {
        if (memory[item].colour)
          hOldMem = GlobalFree (memory[item].hMem);
        else
          hOldMem = LocalFree (memory[item].hMem);
        if (hOldMem)
          MessageBox (hWnd, (LPSTR)"Free function failed",
                      (LPSTR)NULL, MB_OK | MB_ICONHAND);
        else
          memory[item].hMem = 0;
          InvalidateRect (hWnd, (LPRECT)NULL, TRUE);
        }
```

```
      break;

    case IDDISCARD:
      if (memory[item].hMem) {
        hOldMem = FALSE;
        if (memory[item].colour) {
          if (HIBYTE(GlobalFlags(memory[item].hMem))
                                          & GMEM_DISCARDABLE)
            hOldMem = GlobalDiscard (memory[item].hMem);
          }
        else {
          if (HIBYTE(LocalFlags(memory[item].hMem))
                                          & LMEM_DISCARDABLE)
            hOldMem = LocalDiscard (memory[item].hMem);
          }
        if (hOldMem)
          MessageBox (hWnd, (LPSTR)"Discard function failed",
                      (LPSTR)NULL, MB_OK | MB_ICONHAND);
        else
          InvalidateRect (hWnd, (LPRECT)NULL, TRUE);
        }
      break;

    case IDFLAGS:
      if (memory[item].hMem) {
        index = StrCopy(szString, 0, "Lock Count: ", 12, FALSE);
        if (memory[item].colour) {
          flags = GlobalFlags(memory[item].hMem);
          itoa (flags & GMEM_LOCKCOUNT, szNumber, 10);
          index = StrCopy (szString, index, szNumber, 4, TRUE);
          if (flags & GMEM_SWAPPED)
            index = StrCopy (szString, index, "  SWAPPED",
                                              9, FALSE);
          if (flags & GMEM_DISCARDED)
            index = StrCopy (szString, index, "  DISCARDED",
                                              11, FALSE);
          if (flags & GMEM_DISCARDABLE)
            index = StrCopy (szString, index, "  DISCARDABLE",
                                              13, FALSE);
          }
        else {
          flags = LocalFlags(memory[item].hMem);
          itoa (flags & LMEM_LOCKCOUNT, szNumber, 10);
          index = StrCopy (szString, index, szNumber, 4, TRUE);
          if (flags & LMEM_DISCARDED)
            index = StrCopy (szString, index, "  DISCARDED",
                                              11, FALSE);
          if (flags & LMEM_DISCARDABLE)
            index = StrCopy (szString, index, "  DISCARDABLE",
                                              13, FALSE);
          }
        MessageBox(hWnd, (LPSTR)szString, (LPSTR)"Flags",MB_OK);
        }
      break;

    case IDSIZE:
      if (memory[item].hMem) {
        if (memory[item].colour)
          ltoa (GlobalSize(memory[item].hMem), szNumber, 10);
        else
          itoa (LocalSize(memory[item].hMem), szNumber, 10);
        index = StrCopy (szString, 0, szNumber, 4, TRUE);
        StrCopy (szString, index, " BYTES", 6, FALSE);
        MessageBox (hWnd, (LPSTR)szString, (LPSTR)"Size",MB_OK);
        }
      break;

    case IDGLOBALCOMPACT:
      GlobalCompact ((long)-1);
      break;

    case IDLOCALCOMPACT:
      LocalCompact (-1);
      break;

    case IDLOCALFREEZE:
    case IDLOCALMELT:
```

"How to protect your software by letting people copy it."

By Dick Erett, President of Software Security



Inventor and entrepreneur, Dick Erett, explains his company's view on the protection of intellectual property.

"A crucial point that even sophisticated software development companies and the trade press seem to be missing or ignoring is this:

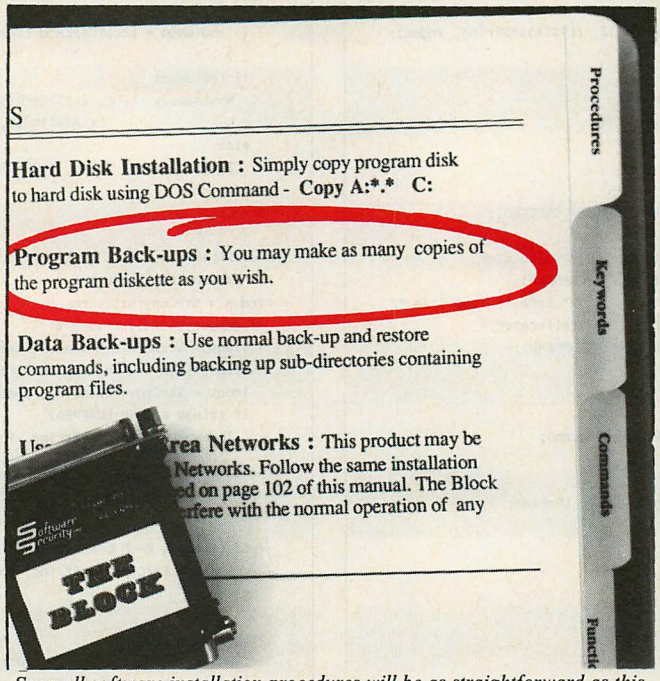
Software protection must be understood to be a distinctively different concept from that commonly referred to as copy protection.

Fundamentally, software protection involves devising a method that prevents unauthorized use of a program, without restricting a legitimate user from making any number of additional copies or preventing program operation via hard disk or LANs.

Logic dictates that magnetic media can no more protect itself from misuse than a padlock can lock itself.

Software protection must reside outside the actual storage media. The technique can then be made as tamper proof as deemed necessary. If one is clever enough, patent law can be brought to bear on the method.

Software protection is at a crossroads and the choices are clear. You can give product away to a segment of the market, or take a stand against the theft of your intellectual property.



Soon all software installation procedures will be as straightforward as this. The only difference will be whether you include the option to steal your product or not.

"...giving your software away is fine..."

We strongly believe that giving your software away is fine, if you make the decision to do so. However, if the public's sense of ethics is determining company policy, then you are no longer in control.

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The BLOCK is the only patented method we know of to protect your investment. It answers all the complaints of reasonable people concerning software protection.

In reality, the only people who could object are those who would like the option of stealing your company's product.

"...eliminating the rationale for copy-busting..."

Since The BLOCK allows a user to make unlimited archival copies the rationale for copy-busting programs is eliminated.

The BLOCK is fully protected by federal patent law rather than the less effective copyright statutes. The law clearly prohibits the production of work-alike devices to replace The BLOCK.

The BLOCK attaches to any communications port of virtually any microcomputer. It comes with a unique customer product number programmed into the circuit.

The BLOCK is transparent to any device attached to the port. Once it is in place users are essentially unaware of its presence. The BLOCK may be daisy-chained to provide security for more than one software package.

Each software developer devises their own procedure for accessing The BLOCK to confirm a legitimate user. If it is not present, then the program can take appropriate action.

"...possibilities... limited only by your imagination..."

The elegance of The BLOCK lies in its simplicity. Once you understand the principle of The BLOCK, hundreds of possibilities will manifest themselves, limited only by your imagination.

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```
    bLocalFreeze ? LocalMelt (0) : LocalFreeze (0);
    bLocalFreeze = !bLocalFreeze;
    hMenu = GetMenu (hWnd);
    EnableMenuItem (hMenu, IDLOCALFREEZE,
                bLocalFreeze ? MF_GRAYED : MF_ENABLED);
    EnableMenuItem (hMenu, IDLOCALMELT,
                bLocalFreeze ? MF_ENABLED : MF_GRAYED);
    break;

  case IDLOCKDATA:
  case IDUNLOCKDATA:
    bLockData ? LockData (0) : UnlockData (0);
    bLockData = !bLockData;
    hMenu = GetMenu (hWnd);
    EnableMenuItem (hMenu, IDLOCKDATA,
                bLockData ? MF_GRAYED : MF_ENABLED);
    EnableMenuItem (hMenu, IDUNLOCKDATA,
                bLockData ? MF_ENABLED : MF_GRAYED);
    break;

  case IDLOCK:
    if (memory[item].hMem) {
      LPSTR Addr = 0;
      if (memory[item].colour)
        Addr = GlobalLock (memory[item].hMem);
      else
        Addr = (LPSTR)LocalLock (memory[item].hMem);
      if (Addr) {
        index = StrCopy(szString, 0, "Address: ", 9, FALSE);
        if (memory[item].colour) {
          ltoa (Addr, szNumber, 16);
          StrCopy (szString, index, szNumber, 8, TRUE);
          }
        else {
          itoa (LOWORD(Addr), szNumber, 16);
          StrCopy (szString, index, szNumber, 4, TRUE);
          }
        MessageBox (hWnd, (LPSTR)szString,
                                    (LPSTR)"Lock", MB_OK);
        }
      else
        MessageBox (hWnd, (LPSTR)"Function Failed",
                                    (LPSTR)"Lock", MB_OK);
      }
    break;

  case IDUNLOCK:
    if (memory[item].hMem)
      MessageBox (hWnd,
                  ((memory[item].colour
                    ? GlobalUnlock (memory[item].hMem)
                    : LocalUnlock (memory[item].hMem))
                  ? (LPSTR)"Block still locked"
                  : (LPSTR)"Block now unlocked"),
                  (LPSTR)"Unlock",
                  MB_OK);
          break;
        }
      }
    }

/*====================================================================*/

BOOL FAR PASCAL AllocProc (hWnd, msg, wParam, lParam)
  HWND          hWnd;
  unsigned      msg;
  WORD          wParam;
  LONG          lParam;
  {
  switch (msg) {
    case WM_INITDIALOG:
      if (memory[item].hMem) {
        SetWindowText (hWnd, (LPSTR)"ReAllocate");
        SetDlgItemInt (hWnd, IDETSIZE, memory[item].size, FALSE);
        if (memory[item].colour) {
          CheckRadioButton (hWnd, IDRBGLOBAL, IDRBLOCAL, IDRBGLOBAL);
          CheckRadioButton (hWnd, IDRBFIXED, IDRBMOVEABLE,
                        (memory[item].flags & GMEM_MOVEABLE) ?
                                        IDRBMOVEABLE : IDRBFIXED);
          CheckDlgButton (hWnd, IDRBDISCARDABLE,
                (memory[item].flags & GMEM_DISCARDABLE) ? 1 : 0);
          CheckDlgButton (hWnd, IDRBNODISCARD,
                (memory[item].flags & GMEM_NODISCARD) ? 1 : 0);
          CheckDlgButton (hWnd, IDRBNOCOMPACT,
                (memory[item].flags & GMEM_NOCOMPACT) ? 1 : 0);
          }
        else {
          CheckRadioButton (hWnd, IDRBGLOBAL, IDRBLOCAL, IDRBLOCAL);
          CheckRadioButton (hWnd, IDRBFIXED, IDRBMOVEABLE,
                        (memory[item].flags & LMEM_MOVEABLE) ?
                                        IDRBMOVEABLE : IDRBFIXED);
          CheckDlgButton (hWnd, IDRBDISCARDABLE,
                (memory[item].flags & LMEM_DISCARDABLE) ? 1 : 0);
          CheckDlgButton (hWnd, IDRBNODISCARD,
                (memory[item].flags & LMEM_NODISCARD) ? 1 : 0);
          CheckDlgButton (hWnd, IDRBNOCOMPACT,
                (memory[item].flags & LMEM_NOCOMPACT) ? 1 : 0);
          }
        }
      else {
        EnableWindow (GetDlgItem (hWnd, IDOK), FALSE);
        SetWindowText (hWnd, (LPSTR)"Allocate");
        SetDlgItemText (hWnd, IDETSIZE,  (LPSTR)"");
        for (i=IDRBGLOBAL; i<=IDRBNOCOMPACT; i++)
          CheckDlgButton (hWnd, i, FALSE);
        }
      return TRUE;
    case WM_COMMAND:
      switch (wParam) {
        case IDRBGLOBAL:
        case IDRBLOCAL:
          if (!memory[item].hMem)
            CheckRadioButton (hWnd, IDRBGLOBAL, IDRBLOCAL, wParam);
          IsAllocOK (hWnd);
          break;

        case IDRBFIXED:
        case IDRBMOVEABLE:
          CheckRadioButton (hWnd, IDRBFIXED, IDRBMOVEABLE, wParam);
          if (wParam == IDRBFIXED)
            CheckDlgButton (hWnd, IDRBDISCARDABLE, FALSE);
          IsAllocOK (hWnd);
          break;

          case  IDRBDISCARDABLE:
            if (IsDlgButtonChecked (hWnd, IDRBDISCARDABLE))
              CheckDlgButton (hWnd, IDRBDISCARDABLE, FALSE);
            else
              if (IsDlgButtonChecked (hWnd, IDRBMOVEABLE))
                CheckDlgButton (hWnd, IDRBDISCARDABLE, TRUE);
            break;

          case  IDRBNOCOMPACT:
            CheckDlgButton (hWnd, IDRBNOCOMPACT,
                        !IsDlgButtonChecked (hWnd, IDRBNOCOMPACT));
            break;

          case  IDRBNODISCARD:
            CheckDlgButton (hWnd, IDRBNODISCARD,
                        !IsDlgButtonChecked (hWnd, IDRBNODISCARD));
            break;

          case IDETSIZE:
            if (HIWORD(lParam) == EN_CHANGE)
              IsAllocOK (hWnd);
            break;

          case IDOK:
            memory[item].flags = 0;
            memory[item].size =
                GetDlgItemInt (hWnd, IDETSIZE, (LPBOOL)&bValOK, FALSE);
            if (IsDlgButtonChecked (hWnd, IDRBGLOBAL)) {  /* global */
              memory[item].colour = TRUE;
              if (IsDlgButtonChecked (hWnd, IDRBMOVEABLE))
```

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TEXAS INSTRUMENTS

261933C

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```
            memory[item].flags |= GMEM_MOVEABLE;
          if (IsDlgButtonChecked (hWnd, IDRBDISCARDABLE))
            memory[item].flags |= GMEM_DISCARDABLE;
          if (IsDlgButtonChecked (hWnd, IDRBNODISCARD))
            memory[item].flags |= GMEM_NODISCARD;
          if (IsDlgButtonChecked (hWnd, IDRBNOCOMPACT))
            memory[item].flags |= GMEM_NOCOMPACT;
          }
        else {                                      /* local */
          memory[item].colour = FALSE;
          if (IsDlgButtonChecked (hWnd, IDRBMOVEABLE))
            memory[item].flags |= LMEM_MOVEABLE;
          if (IsDlgButtonChecked (hWnd, IDRBDISCARDABLE))
            memory[item].flags |= LMEM_DISCARDABLE;
          if (IsDlgButtonChecked (hWnd, IDRBNODISCARD))
            memory[item].flags |= LMEM_NODISCARD;
          if (IsDlgButtonChecked (hWnd, IDRBNOCOMPACT))
            memory[item].flags |= LMEM_NOCOMPACT;
          }
        EndDialog(hWnd, memory[item].hMem =
             (memory[item].hMem
             ? (IsDlgButtonChecked (hWnd, IDRBGLOBAL)
              ? GlobalReAlloc (memory[item].hMem, (unsigned long)
                    memory[item].size, memory[item].flags)
              : LocalReAlloc (memory[item].hMem,
                    memory[item].size, memory[item].flags))
             : (IsDlgButtonChecked (hWnd, IDRBGLOBAL)
              ? GlobalAlloc (memory[item].flags,
                    (unsigned long) memory[item].size)
              : LocalAlloc (memory[item].flags,
                                  memory[item].size))));
        break;

      case IDCANCEL:
        EndDialog(hWnd, FALSE);
        break;
      }                                 /* end of switch        */
    break;                              /* end of WM_COMMAND    */

    default:
      return FALSE;
    }
  return TRUE;
  }

BOOL IsAllocOK (hWnd)
  HWND  hWnd;
  {
  GetDlgItemInt (hWnd, IDETSIZE,  (LPBOOL)&bValOK, FALSE);
  if (!bValOK)
    EnableWindow (GetDlgItem (hWnd, IDOK), FALSE);
  else
    if ((IsDlgButtonChecked (hWnd, IDRBGLOBAL)
      || IsDlgButtonChecked (hWnd, IDRBLOCAL))
     && (IsDlgButtonChecked (hWnd, IDRBFIXED)
      || IsDlgButtonChecked (hWnd, IDRBMOVEABLE)))
      {
      EnableWindow (GetDlgItem (hWnd, IDOK), TRUE);
      return TRUE;
      }
  return FALSE;
  }
int StrCopy (new, newIndex, old, width, padleft)
  char  new[],  old[];
  int   width,  newIndex;
  BOOL  padleft;
  {
  int   n,      oldStrLen;

  for (oldStrLen=0; old[oldStrLen]; oldStrLen++);
  if (padleft) {
    if (width != oldStrLen)
      for (n = width - oldStrLen; n; n--, newIndex++)
        new[newIndex] = ' ';
    }
  for (n=0; new[newIndex]=old[n]; n++, newIndex++);
  return newIndex;
  }
```

```
/*============================================================*/
int PASCAL WinMain (hInstance, hPrevInstance, lpszCmdLine, cmdShow)
  HANDLE                hInstance;
  HANDLE                hPrevInstance;
  LPSTR                 lpszCmdLine;
  int                   cmdShow;
  {
  MSG                   msg;
  HWND                  hWnd;

  if (!hPrevInstance) {
    if (!MainInit (hInstance))
      return FALSE;
    }

  hWnd = CreateWindow ((LPSTR)"Demo", (LPSTR)"1",
              WS_TILEDWINDOW, 0, 0, 0, 0, (HWND)NULL, (HMENU)NULL,
              (HANDLE)hInstance,  (LPSTR)NULL);
  hInst     = hInstance;
  lpAllocProc = MakeProcInstance ((FARPROC)AllocProc, hInstance);

  ShowWindow (hWnd, cmdShow);
  UpdateWindow (hWnd);

  while (GetMessage((LPMSG)&msg, NULL, 0, 0)) {
    TranslateMessage ((LPMSG)&msg);
    DispatchMessage ((LPMSG)&msg);
    }
  return (int)msg.wParam;
  }

BOOL MainInit (hInstance)
  HANDLE        hInstance;
  {
  PWNDCLASS pMainClass = (PWNDCLASS)LocalAlloc(LPTR,sizeof(WNDCLASS));
  pMainClass->hCursor        = LoadCursor (NULL, IDC_ARROW);
  pMainClass->hIcon          = LoadIcon (NULL, IDI_APPLICATION);
  pMainClass->lpszMenuName   = (LPSTR)"MainMenu";
  pMainClass->lpszClassName  = (LPSTR)"Demo";
  pMainClass->hbrBackground  = (HBRUSH)GetStockObject (WHITE_BRUSH);
  pMainClass->hInstance      = hInstance;
  pMainClass->style          = CS_HREDRAW | CS_VREDRAW;
  pMainClass->lpfnWndProc    = MainWndProc;
  if (!RegisterClass((LPWNDCLASS)pMainClass))
    return FALSE;
  LocalFree ((HANDLE)pMainClass);
  return TRUE;
  }
/*------------------------------------------------------------*/
/* End of file:  MEMMGR.C                                     */
/**************************************************************/
```

LISTING 2: MEMMGR.DEF

```
;************************************************************:
; Filename:     MEMMGR.DEF                                   :
;                                                            :
; Description:  Link definition file                         :
;------------------------------------------------------------:

NAME    MEMMGR

STUB    '..\WINSTUB.EXE'

CODE    MOVEABLE
DATA    MOVEABLE MULTIPLE

HEAPSIZE  4096
STACKSIZE 4096

EXPORTS
    MainWndProc @1
    AllocProc   @2

;------------------------------------------------------------:
; End of file:  MEMMGR.DEF                                   :
;************************************************************:
```

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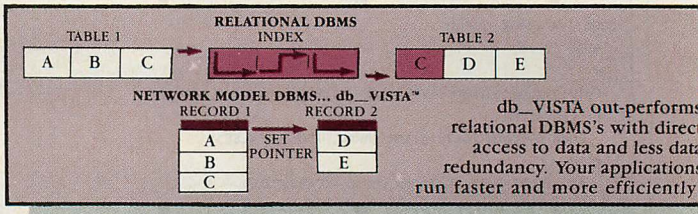


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PT107

LISTING 3: MEMMGR.H

```
/*****************************************************************/
/* Filename:     MEMMGR.H                                        */
/*                                                               */
/* Description:  Header file                                     */
/*---------------------------------------------------------------*/

#define IDITEM01        1001
#define IDITEM02        1002
#define IDITEM03        1003
#define IDITEM04        1004
#define IDITEM05        1005
#define IDITEM06        1006
#define IDITEM07        1007
#define IDITEM08        1008
#define IDITEM09        1009
#define IDITEM10        1010
#define IDITEM11        1011
#define IDITEM12        1012
#define IDITEM13        1013
#define IDITEM14        1014
#define IDITEM15        1015
#define IDITEM16        1016

#define IDALLOCATE      1021
#define IDLOCK          1022
#define IDUNLOCK        1023
#define IDFLAGS         1024
#define IDFREE          1025
#define IDDISCARD       1026
#define IDSIZE          1027
#define IDLOCALFREEZE   1028
#define IDLOCALMELT     1029
#define IDLOCKDATA      1030
#define IDUNLOCKDATA    1031
#define IDGLOBALCOMPACT 1032
#define IDLOCALCOMPACT  1033
#define MEMDLGBOX       1034
#define IDRBGLOBAL      1035
#define IDRBLOCAL       1036
#define IDRBFIXED       1037
#define IDRBMOVEABLE    1038
#define IDRBDISCARDABLE 1039
#define IDRBNODISCARD   1040
#define IDRBNOCOMPACT   1041
#define IDETSIZE        1042

/*---------------------------------------------------------------*/
/* End of file:  MEMMGR.H                                        */
/*****************************************************************/
```

LISTING 4: MEMMGR.RC

```
/*****************************************************************/
/* Filename:     MEMMGR.RC                                       */
/*                                                               */
/* Description:  Resource description file                       */
/*---------------------------------------------------------------*/

#include "style.h"
#include "memmgr.h"

MainMenu MENU
BEGIN
  POPUP "Item"
  BEGIN
    MENUITEM    " 1",               IDITEM01
    MENUITEM    " 5",               IDITEM05
    MENUITEM    " 9",               IDITEM09
    MENUITEM    "13",               IDITEM13
    MENUITEM    " 2",               IDITEM02, MENUBARBREAK
    MENUITEM    " 6",               IDITEM06
    MENUITEM    "10",               IDITEM10
    MENUITEM    "14",               IDITEM14
    MENUITEM    " 3",               IDITEM03, MENUBARBREAK
    MENUITEM    " 7",               IDITEM07
    MENUITEM    "11",               IDITEM11
    MENUITEM    "15",               IDITEM15
    MENUITEM    " 4",               IDITEM04, MENUBARBREAK
    MENUITEM    " 8",               IDITEM08
    MENUITEM    "12",               IDITEM12
    MENUITEM    "16",               IDITEM16
  END
  POPUP "Options"
  BEGIN
    MENUITEM    " ",                IDALLOCATE
    MENUITEM    SEPARATOR
    MENUITEM    "Lock",             IDLOCK
    MENUITEM    "UnLock",           IDUNLOCK
    MENUITEM    "Flags",            IDFLAGS,        MENUBARBREAK
    MENUITEM    "Free",             IDFREE
    MENUITEM    "Discard",          IDDISCARD
    MENUITEM    "Size",             IDSIZE
    MENUITEM    "LocalFreeze",      IDLOCALFREEZE,  MENUBARBREAK
    MENUITEM    "LocalMelt",        IDLOCALMELT
    MENUITEM    "LockData",         IDLOCKDATA
    MENUITEM    "UnlockData",       IDUNLOCKDATA
  END
  POPUP "Compact"
  BEGIN
    MENUITEM    "Global",           IDGLOBALCOMPACT
    MENUITEM    "Local",            IDLOCALCOMPACT
  END
END

MEMDLGBOX DIALOG   10, 50, 192, 56

STYLE WS_BORDER | WS_CAPTION | WS_DLGFRAME | WS_POPUP
BEGIN
  GROUPBOX     "Colour",       -1,              2,  2, 60, 36
  RADIOBUTTON "Global",        IDRBGLOBAL,      4, 12, 56, 12,WS_TABSTOP
  RADIOBUTTON "Local",         IDRBLOCAL,       4, 24, 56, 12,WS_TABSTOP
  GROUPBOX     "Flavor",       -1,             66,  2, 60, 36
  RADIOBUTTON "Fixed",         IDRBFIXED,      68, 12, 56, 12,WS_TABSTOP
  RADIOBUTTON "Moveable",      IDRBMOVEABLE,   68, 24, 56, 12,WS_TABSTOP
  RADIOBUTTON "Discardable",   IDRBDISCARDABLE,132,  2, 56, 12,WS_TABSTOP
  RADIOBUTTON "NoDiscard",     IDRBNODISCARD,  132, 14, 56, 12,WS_TABSTOP
  RADIOBUTTON "NoCompact",     IDRBNOCOMPACT,  132, 26, 56, 12,WS_TABSTOP
  LTEXT        "Size:",        -1,              2, 44, 20,  8
  EDITTEXT                     IDETSIZE,       34, 42, 28, 12
  PUSHBUTTON   "Ok",           IDOK            66, 42, 60, 12
  PUSHBUTTON   "Cancel",       IDCANCEL,      130, 42, 60, 12
END

/*---------------------------------------------------------------*/
/* End of file:  MEMMGR.RC                                       */
/*****************************************************************/
```

LISTING 5: MEMMGR

```
#*****************************************************************#
# Filename:     MEMMGR.                                           #
#                                                                 #
# Description:  "MAKE" description file                           #
#-----------------------------------------------------------------#

memmgr.obj: memmgr.c memmgr.h
    cl -d -c -AS -Gsw -Os -Zpe memmgr.c

memmgr.res: memmgr.rc memmgr.h
    rc -r memmgr.rc

memmgr.exe: memmgr.obj memmgr.res memmgr.def
    link4 memmgr,/align:16,/map,slibw,memmgr.def
    rc memmgr.res

#-----------------------------------------------------------------#
# End of file:  MEMMGR                                            #
#*****************************************************************#
```

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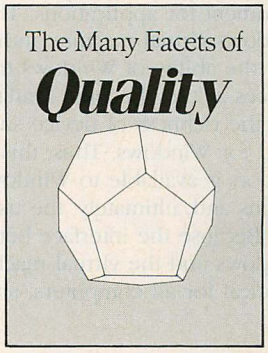
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Windows Virtual Machine

Microsoft Windows augments DOS to provide a uniform, device-independent operating environment—a virtual machine interface for applications.

GUY QUEDENS

Consider what Microsoft Windows provides the user: a uniform, graphics-oriented, multitasking environment. Then consider that Windows delivers to software developers a hardware-independent environment. Control and management of system resources is so complete that programs written under Windows can be thought of as executing on the *Windows virtual machine*, not on the system hardware.

What we will call the Windows virtual machine is a number of machine-dependent support modules that provide the I/O support needed by Windows to execute on any given computer system. This virtual machine allows Windows to extend the functionality of DOS. Together, Windows and the virtual machine coordinate the control of system resources, providing a harmonious, standardized operational environment for applications. The phrase Windows virtual machine indicates not only the ability of Windows to use new devices as they become available, but also the richness of device support defined for Windows. Thus, this device support is available to Windows applications and, ultimately, the user.

Because the interface between Windows and the virtual machine is identical for all computers, application code becomes machine independent. Because device manufacturers are responsible for developing device drivers for their equipment, device performance can be optimized while maintaining uniformity of access.

PAST, PRESENT, AND FUTURE

A brief examination of the structural models of DOS and Microsoft Windows reveals a fuller appreciation of Windows' offerings. Originally, DOS was developed to provide dedicated services for a limited number of devices. In fact, early versions supported no devices that could be conveniently shared (such as hard disks), and DOS itself had to be modified each time support for a new device was added. Later versions provided standard support for more devices, allowing the definition and addition of device drivers that worked in conjunction with DOS to support new devices.

The structure of the current DOS implementation is illustrated in figure 1. Because of the low performance and incompleteness of many services provided by DOS or the PC BIOS, many developers have intentionally bypassed them, choosing instead to address resources directly. Such a strategy often produces software products that are operationally efficient for particular target configurations, but they can be difficult to implement and maintain on evolving hardware platforms.

Windows is a cooperative, nonpreemptive, device-independent environment. From an applications point of view, it replaces DOS by managing system resources and providing a uniform user interface. Application programs must cooperate by requesting services and the allocation of resources from Windows, which calls upon the Windows virtual machine to perform those functions. The Windows structural model is illustrated in figure 2.

WinApps, applications written using the Windows application programming interface, execute only in the Windows environment. OldApps, applications that predate WinApps, can be executed in the DOS or Windows environment, but cannot be multitasked with WinApps or with each other.

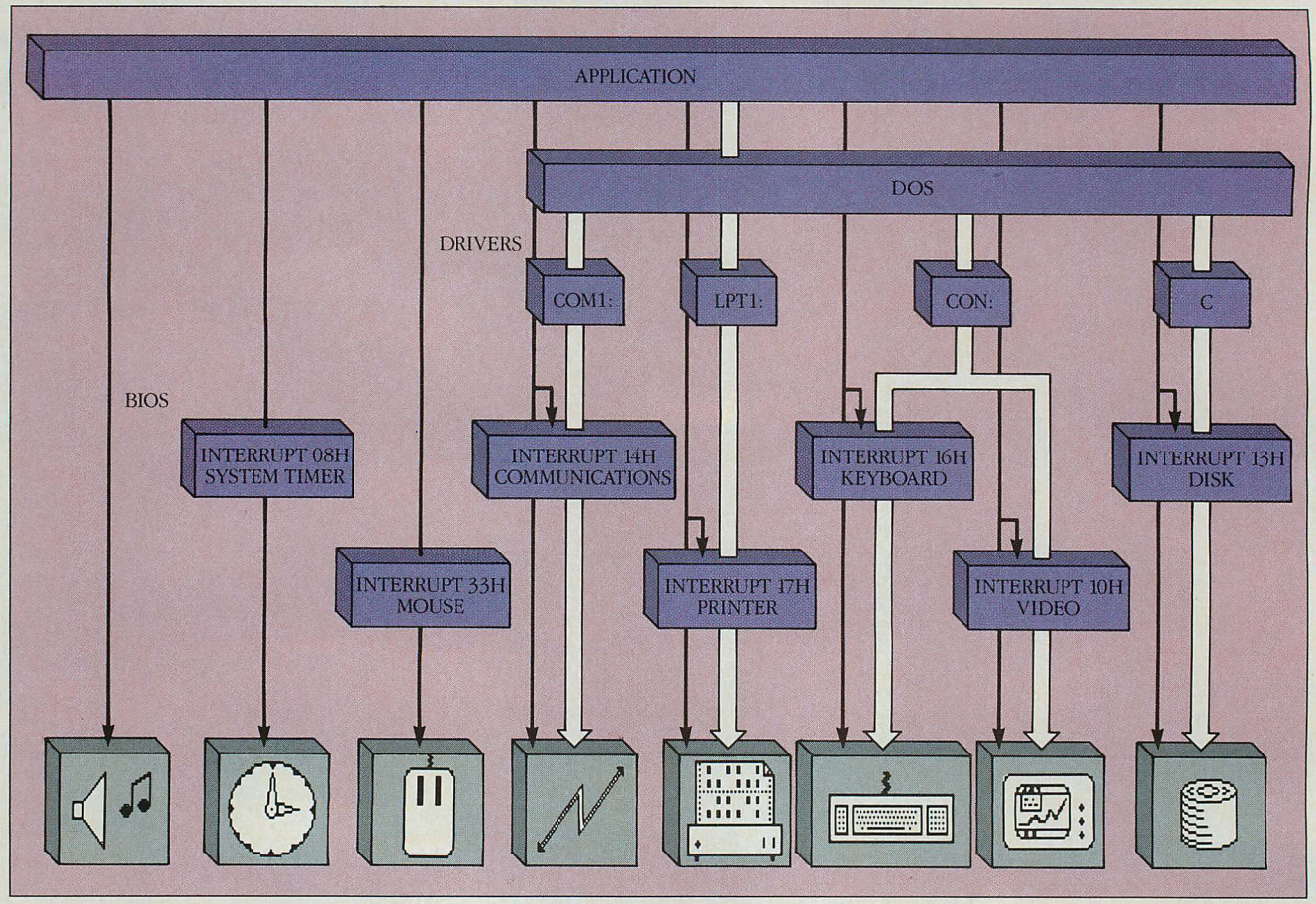
The Windows modules KERNEL, USER, and GDI (for Graphics Device Interface) take control of all resources and maintain the user interface for all Windows applications. These modules comprise the windowing support layer of Windows itself.

KERNEL controls and allocates all machine resources. It works with DOS

ILLUSTRATION • FRANK RILEY


Edit
MC
7
8
MR
4
5
6
M+
1
2
3
Clock
CLIPB
CLOCK.E
CONTROL.E
COURA.FON

FIGURE 1: *MS-DOS Structure*



Because of the low performance and incompleteness of many services provided by DOS and the PC BIOS, many software packages bypass them and address resources directly. Operation may be efficient, but maintenance is difficult.

to load applications, manage memory, and schedule task execution.

USER is responsible for the creation and maintenance (move, size, or destroy) of windows on the system display. USER also controls icons, cursors, and sends mouse, keyboard, and timer input to the appropriate application. Input is sent to the application in the currently selected window. A window is selected by pressing and releasing the mouse button when the pointer is anywhere within that window. The Alt-Tab key sequence also may be used to select the next window in a top-to-bottom, left-to-right sequence.

The GDI is a rich graphics language that carries out or simulates (using a series of less-complicated operations) the graphics operations needed to create images on the system display and all other display devices. The GDI's design is generalized to support a range of technologies. It can uniformly drive a smart vector plotter and a high-speed raster display.

The GDI requires that a minimum set of functions be implemented, but never requires a driver to carry out complicated functions it cannot handle. It determines from the driver the capabilities of the device and the driver and the functions the GDI must emulate.

Windows and WinApps never communicate directly with hardware devices. Instead they operate together as a machine-independent entity, relying on the OEM-supplied drivers that make up the Windows virtual machine. Because drivers are supplied by device vendors, hardware can be upgraded without program changes.

WHAT AND WHERE

A device driver is a Windows support module that provides access to a device by performing the device-specific actions necessary to provide the services requested by Windows. Microsoft provides device drivers for common system devices on the Windows distribution diskettes. Equipment vendors also develop and provide Windows device drivers. In addition to detailed knowledge about the device, these items are required to develop a Windows device driver: Microsoft Windows, Windows Software Development Kit, Adaptation Kit, and a compiler or assembler that uses Windows calling and segment conventions. See "Windows of Opportunity," Paul Grayson, February 1987, p. 70. for information on the Software Development Kit. Currently, the Adaptation Kit is free (by signing of a nondisclosure agreement) to purchasers of the Software Development Kit. Sample source code for several device drivers is provided with the kit.

Once a device driver has been obtained from Microsoft (or the device vendor) or has been developed using the products mentioned above, it can be copied to the Windows distribution diskette for installation by the Windows setup program. On the surface, the Windows installation procedure, SETUP, presents a series of menus that allows the specification of hardware on which Windows will be running. Under the surface, SETUP is busily copying and combining files from the distribution diskettes to the hard disk, as evidenced by a message to that effect.

These files are, collectively, the virtual machine and have the extension .DRV. As setup proceeds, it copies the user-selected modules into the Windows runtime file, WIN100.BIN.

The modules that make up the Windows virtual machine are categorized into three groups: input support, output support, and miscellaneous. Input support handles the pointing device, the keyboard, and the system timer. Output support handles GDI devices, such as the system display, printers, and plotters. The miscellaneous modules handle other devices, such as communications and sound generation. Each of these modules provides a set of predefined functions that Windows uses to provide the resources and support required by applications.

INPUT SUPPORT MODULES

Three input support modules have been defined: MOUSE, SYSTEM, and KEYBOARD. MOUSE, the pointing-device module, provides support for the system mouse. SYSTEM provides information about timer resolution, system disk drives, and allows installation of system hooks. KEYBOARD preempts the normal keyboard hardware interrupt and provides a number of functions concerning the system keyboard.

The Pointing-device Module. MOUSE defines some pointing device, such as a mouse, joystick, or digitizing pad. It is loaded when Windows starts up. This module preempts any existing pointing-device input routines.

Windows requires a pointing-device module, but not a pointing device. If no pointing device is used, a minimal stub will suffice. This stub contains functions that inform Windows that no pointing device is present.

When Windows begins operation (see figure 3), it calls the pointing-device module function

Inquire(lpMOUSEINFO)

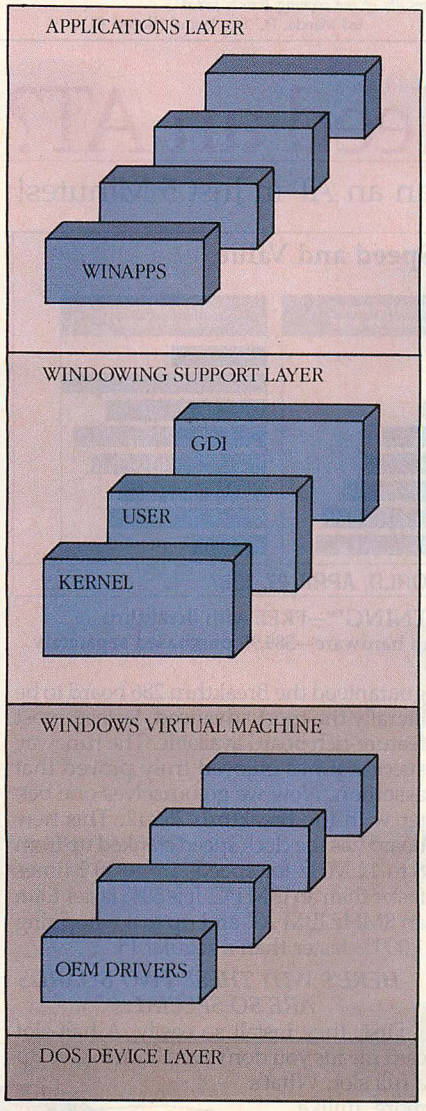
where **lpMOUSEINFO** is a long pointer to a data structure. The **Inquire** function gives the supplied structure with capability: whether a pointing device exists, number of buttons, hardware interrupt generation rate, and horizontal and vertical acceleration threshold.

Once Windows has established the existence of a pointing device, it will call the function

Enable(lpEventFunc)

where **lpEventFunc** is a long pointer to an event function that generates mouse-event messages. **Enable** preempts the existing pointing-device handler by replacing the device interrupt vector with a vector to the mouse interrupt routine within itself. **Enable** then goes on to save the old vector location so that it can be restored when Windows terminates.

FIGURE 2: *Windows Structure*



Windows calls upon the Windows virtual machine to perform functions requested by application programs.

The mouse interrupt routine is invoked whenever the user initiates some form of mouse activity (such as moving the mouse, pressing the button, and so on). This routine places the activity information into a standardized format and calls the event function that was supplied when **Enable** was invoked. The event function carries out all further processing, such as putting messages in the system queue to indicate that a mouse event has occurred. These messages are routed to the appropriate application by Windows.

Finally, the function **Disable()** is called when Windows wishes to disable the pointer interrupt routine and restore the previous interrupt vector.

The System Driver. The system device module, SYSTEM, contains the timer routines that provide timer input. It also contains routines that describe system disk-drives and allow the enabling and disabling of system-dependent hooks. As with the MOUSE driver, the system device driver is loaded when Windows begins operation.

As demonstrated in figure 4, Windows, when it begins operation, calls the system device function

InquireSystem(wCommand,wDevice)

where **wCommand** is an unsigned integer value specifying the type of system information requested. The field **wDevice** is dependent on **wCommand**. With **wCommand** set to equal 0, the timer resolution is returned in microseconds (**wDevice** is not used). With **wCommand** set to 1, the disk-drive information is returned for the drive number in **wDevice**. With **wCommand** set to 2, a request is issued to enable (**wDevice** set to 0) or to disable (**wDevice** set to 1) any system-dependent hooks. Such a hook is some action that an OEM device needs to perform before Windows begins formal operations. A hook can be the execution of special code in the BIOS that is executed only when Windows is running.

Once Windows has retrieved timer information via **InquireSystem**, it calls

EnableSystemTimers()

This function installs itself by replacing the timer interrupt vector with a vector to a routine within itself and saving the old vector location.

The Windows timer function

DisableSystemTimers()

restores the vector of the previous timer service routine, thereby disabling the system timer.

The system module must maintain a data structure called a timer event table. This table consists of a number of three-item fields. While there is no standard definition on how this table should be arranged, a typical structure is as follows:

```
TimeTable   STRUC
wRate       dw      ?
wCount      dw      ?
lpFunc      dd      ?
TimeTable   ENDS
```

The field **wRate** contains the interval in milliseconds between calls to the

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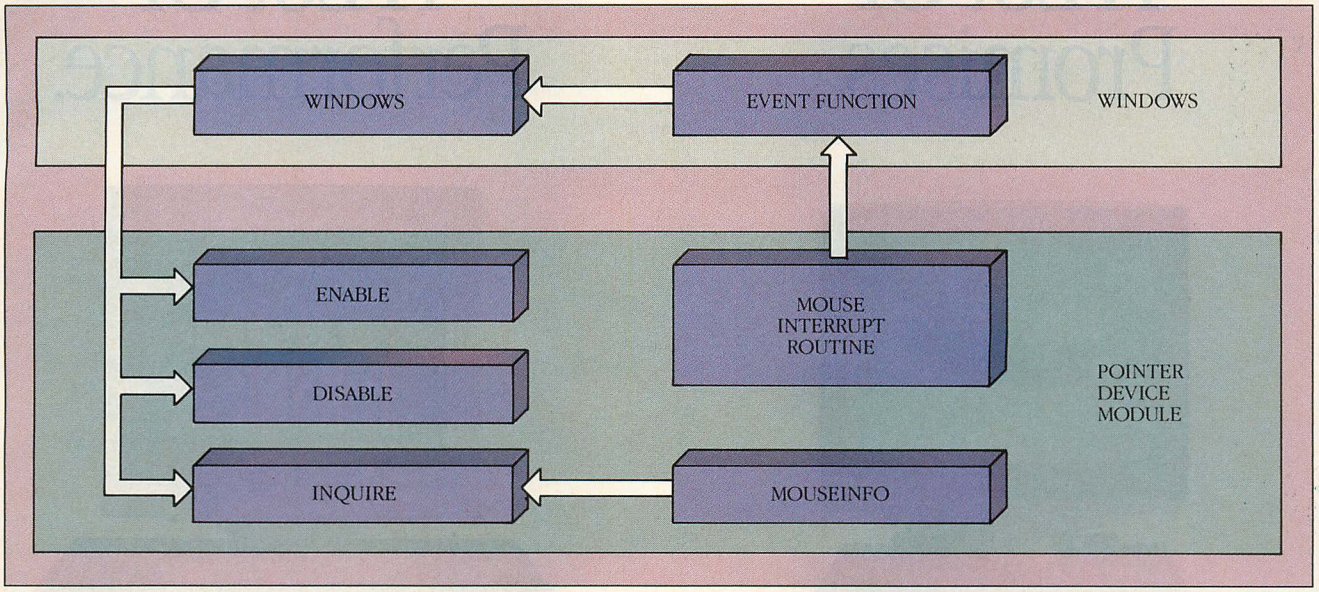
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FIGURE 3: *MOUSE Device Module*



Once enabled, the interrupt routine formats input data and passes them to the Event function, which in turn passes the event message to Windows. Once Windows has established the existence of the pointing device, it will then call the function.

function in the field **lpFunc**. The field **wCount**, contains a count representing the number of timer interrupts since the last call was made to the entry's event function.

The Windows timer function

CreateSystemTimer(wRate,lpFunc)
:hTimer

adds a timer event entry into the timer event table by copying **wRate** and **lpFunc** into a vacant slot and setting the **wCount** field to zero. Finally, the function returns a unique handle, **hTimer**, that identifies the new table entry. If there are no free entries, **hTimer** returns NULL.

The timer routine is called whenever the timer interrupt is asserted. This code serves the dual purpose of updating the timer event table and calling the timer event functions whenever they are required. The code then passes the control over to the previous routine for the execution of any of the realtime tasks that are not directly related to Windows.

The final function that must be defined within this module is

KillSystemTimer(hTimer):hTimer

This function removes the specified entry from the timer event table. The return value **hTimer** is NULL if the operation is successful.

The Keyboard Driver. The device module KEYBOARD contains the system routines required to process keyboard input and convert this input into *Windows virtual key codes* (generic codes that all applications understand) and ANSI or OEM-specific character values.

Windows insures device independence by converting all keystrokes into Windows virtual key codes, which represent actual keyboard keys, not character values, thereby implying that keyboard input does not depend on the character set of the computer. There are 256 possible key codes, although not all systems use all codes. Windows has defined a minimum standard virtual key set that includes letter, digit, function, and cursor keys.

KEYBOARD provides default conversion routines to translate virtual keys to ANSI character values, as well as to a specific system's own OEM-specific character values.

As indicated in figure 5,

Inquire(lpKBINFO)

is called by Windows as it initializes; **lpKBINFO** is a long pointer to a data structure KBINFO. **Inquire** fills in KBINFO with certain capability information: Kanji keyboard capabilities, size of a state information array, number of function keys, make/break capability, and the rate at which the keyboard can generate hardware interrupts.

After **Inquire**, Windows calls

Enable(lpEventFunc,lpKeyState)
:bEnabled

to enable the keyboard interrupt routine. **Enable** preempts any existing keyboard routine by replacing the device interrupt vector with a vector that points to the interrupt handler contained within itself. It also initializes the state table pointed to by **lpKeyState**, which indicates the current state of each of the 256 virtual keys.

Whenever a user presses or releases a key, control is passed to the keyboard interrupt routine. The routine fetches the keyboard scan code and transition state (make/break). Next, the key event is translated into a Windows virtual key code using a virtual key translation table provided by the OEM. Finally, **EventFunc** is called and carries out all further keyboard processing. Usually, this would involve the placing of a message in the system queue that is then routed to the application (as appropriate) by Windows.

A call to **Disable( )** instructs the driver to detach itself and restore the previous interrupt service routine.

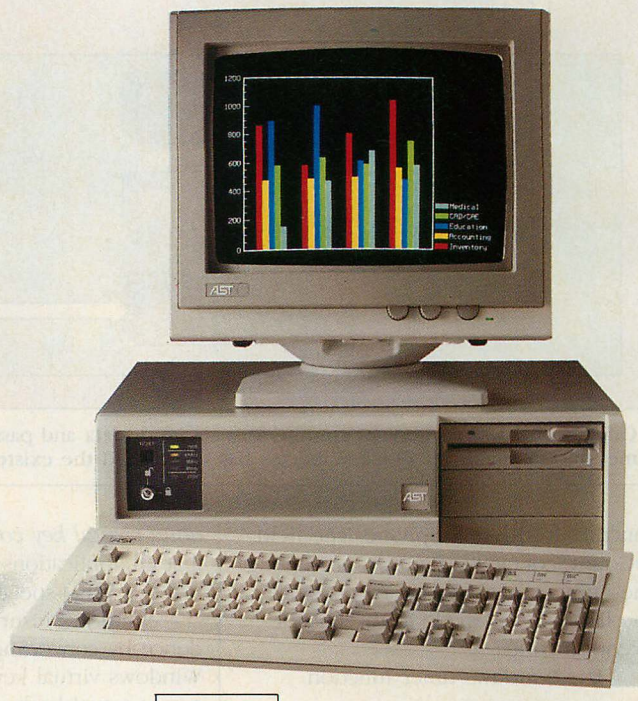
Several default translation routines are supplied by the OEM. One such routine, **ToAscii**, converts a virtual keycode to an ANSI character code. **DoLights**, a routine internal to **ToAscii**, is responsible for turning the key state indicators (LEDs) on the keyboard on or off, depending on the current state of the toggle keys. Windows accesses **DoLights** by sending an undefined virtual key code to **ToAscii**.

The OEM must make **AnsiToOem** and **OemToAnsi** functions available to applications. These convert ANSI character set strings to and from OEM-specific character strings.

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AST Premium/286 (10/0)	***2.25***	***1.41***	***2.12***
IBM PC AT (6/1)	1.00	1.00	1.00
IBM PC XT-™286 (6/0)	1.32	1.33	1.03
IBM PC AT (8/1)	1.37	1.17	1.40
IBM PS/2 Model 50 (10/1)	1.71	1.70*	1.19*
IBM PS/2 Model 60 (10/1)	1.72	2.02	1.67

*With RAM cache: seq. 1.92, ran. 1.03
Source: InfoWorld Hardware Benchmark System, as published in InfoWorld May 11, 1987

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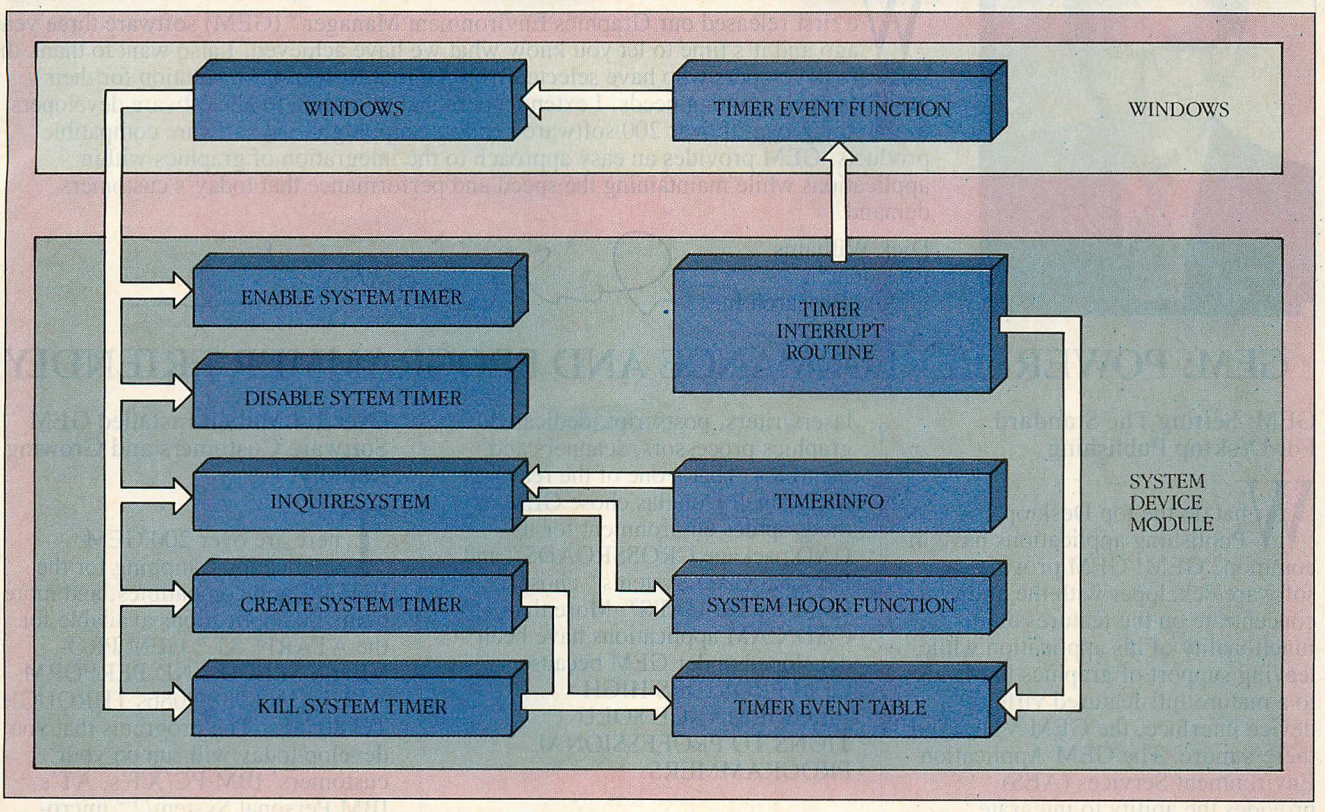
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FIGURE 4: *SYSTEM Device Module*



The system device module, SYSTEM, contains the timer routines that provide timer input. This module also contains routines that describe system disk-drive information, and in addition it allows the enabling and disabling of system-dependent hooks.

OUTPUT SUPPORT MODULES

Graphics output devices are coupled to the GDI by output support modules. Output functions made by Windows and its applications go through the GDI to achieve the desired results. This not only insures, but also enforces a uniformly driven system.

A Windows system must have a minimum of one GDI support module for support of the system display. All other output support devices, such as printers or plotters, must have their own GDI support. Implementation of this driver is the responsibility of the output device OEM.

A complete GDI support module can be fairly complex, however, few OEMs will implement all GDI functions. It is up to the support module writer to decide where actions will be performed and to set up the simulation-request vectors so that the GDI can determine how to handle output primitives for that device.

GDI support modules must register themselves by identifying both the graphics peripheral's technology and the operations that the support module is able to perform when it is using the peripheral in question. This allows the GDI to decide how best to compensate for functions that may be missing in the support module.

The functionality of the GDI support module can range from being very lean (relying on the GDI to perform most of the work) to being very rich (capable of performing all of the GDI primitives). For example, to draw a circle, the GDI can tell the driver to draw a number of line segments (thus, the driver never knows it is drawing a circle), or it can simply issue a circle command, in which case the driver either reduces the command or passes the circle command on to the underlying hardware. This flexibility also allows the developer of a rich driver to start off lean, taking advantage of the GDI to simulate the more complex functions and, therefore, allowing the driver to be built incrementally.

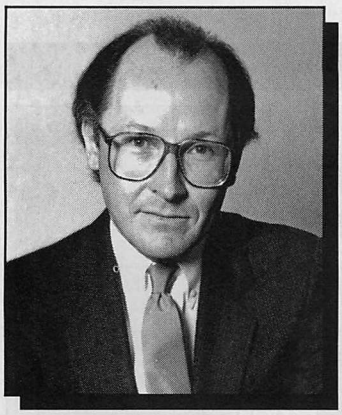
These routines are required of all GDI support modules: **Enable**, **Disable**, **ColorInfo**, **RealizeObject**, **Pixel** (set), and **Output** (line and scanline). In addition to the basic functions, the dedicated system display must also support **Bitblt**, **Strblt**, **ScanLR**, **Inquire**, **SetCursor**, and **MoveCursor**; a vector plotter must be able to support **Strblt**.

Output functions performed by a GDI module can be divided into the following five categories: Control, which initializes and terminates devices; Information, which describes device physical characteristics and support-module capabilities; Output, which performs output to device; Attribute, which handles the creation of the actual parameters for the device-specific output functions; and, finally, Cursor, which provides cursor support.

Control Functions. Windows calls **Enable** to initialize the driver and obtain information, such as physical characteristics (device type, size of output surface, resolution, colors, and so on) and information about the support-module capabilities.

DeviceMode is called to set up a dialogue box that displays the current device environment (or parameters) and allows changes to be made. For example, the Epson FX-80 support module allows the user to change, among other things, "Print Quality (High or Low)." Typically, this function is called from the Windows Control Panel (CONTROL.EXE). **Disable** restores the device to the state it was in prior to the **Enable** call.

Information Functions. The function **ColorInfo** converts RGB colors to and from physical colors. **EnumObj** enu-



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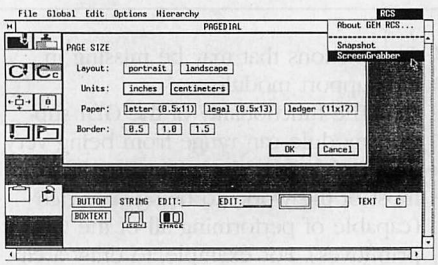
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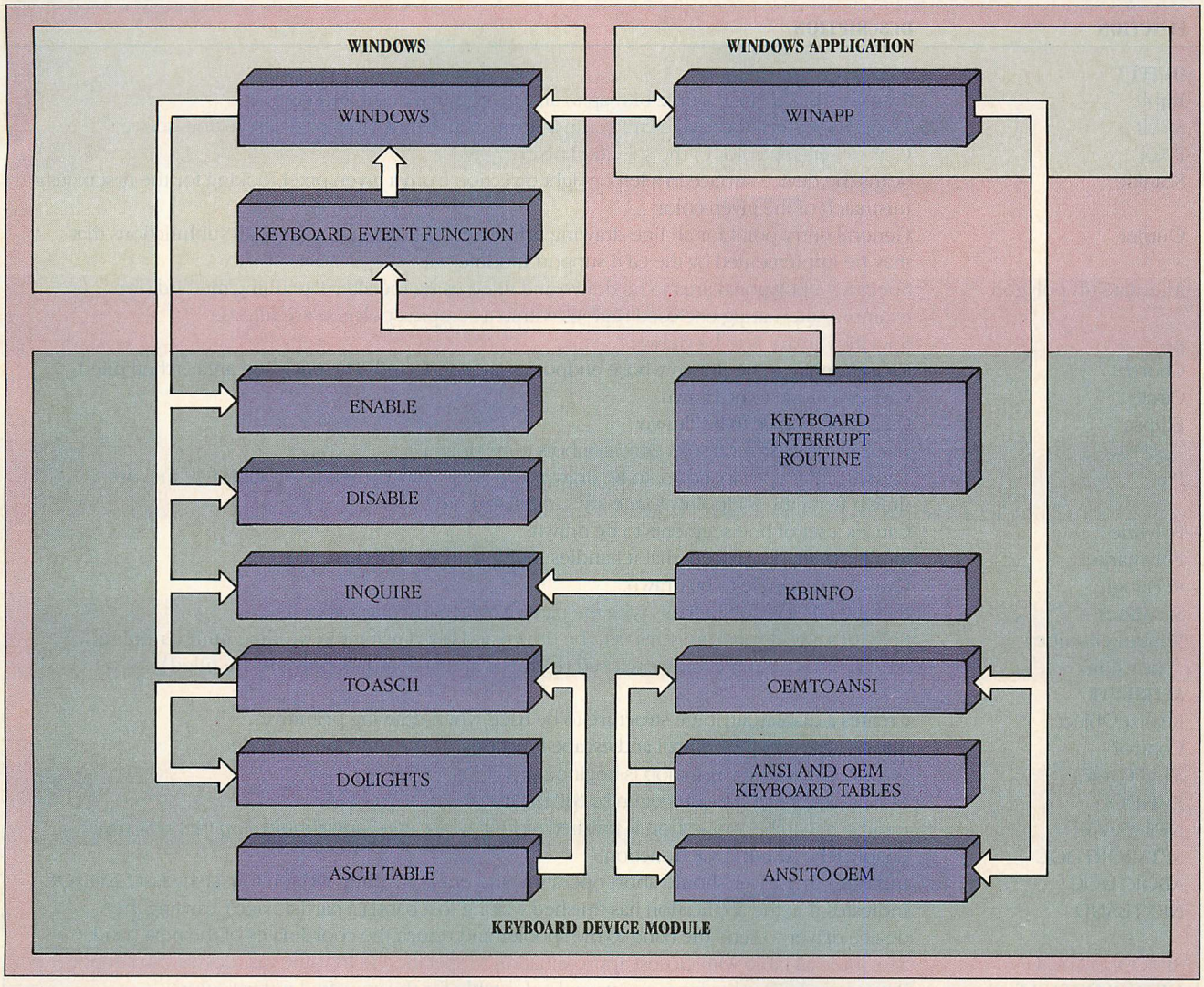
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FIGURE 5: *KEYBOARD Device Module*



Whenever a user presses or releases a key, control is passed to the keyboard interrupt routine. The key event is translated into a Windows virtual key code and a key-event message is posted. This feature contributes to device independence.

merates the pens and brushes available on a device. **EnumDFonts** enumerates the fonts available on the device. The output, attribute, and cursor functions are described in table 1.

MISCELLANEOUS MODULES

A number of miscellaneous support modules must be available in order to form the complete Windows system. These requirements include a logo driver, a communications driver, a sound driver, an OldApps support module, and a disk formatter module.

The logo driver: .LGO. This driver is relatively simple, yet it is OEM dependent. The logo driver is stored in a file with the name of the system display device video driver, but with the extension .LGO. Executed as part of the start-up process, the logo driver displays a Windows logo on the user's display screen.

The Communications Driver: COMM. The system communication module, COMM, provides all functions necessary to communicate via an RS-232 serial port. Windows calls COMM to perform a variety of functions. This driver is straightforward; as shown in table 2, it provides functions for setting up devices and queues, sending and receiving data, detecting or ignoring changes in line control signals, and controlling the flow of data.

The Sound Driver: SOUND. The system speaker module, SOUND, provides all of the functions necessary to generate sound. There exists a one-to-one correspondence between calls available to application programs and functions within the SOUND module, with one exception: the Windows function

MessageBeep(wType):bBeep

is implemented as DOBEEP within the SOUND module. Because of the one-to-one correspondence, its functions are merely listed in table 3 without restating the information that can be found in the *Windows Programmer's Reference* manual.

Old Application Support. A Windows design criterion is that it must provide support to OldApps. This stipulation categorizes OldApps into three groups: the good, the bad, and the ugly.

A "good" application (GoodApp) uses only interrupt 10H or interrupt 21H for all I/O calls and requests memory allocation through DOS. Thus, it is well behaved and can run in a window.

A "bad" application (BadApp) writes directly to the screen or uses other system resources directly. To accommodate a BadApp, Windows saves the screen, relinquishes control to the

TABLE 1: *GDI Output Functions*

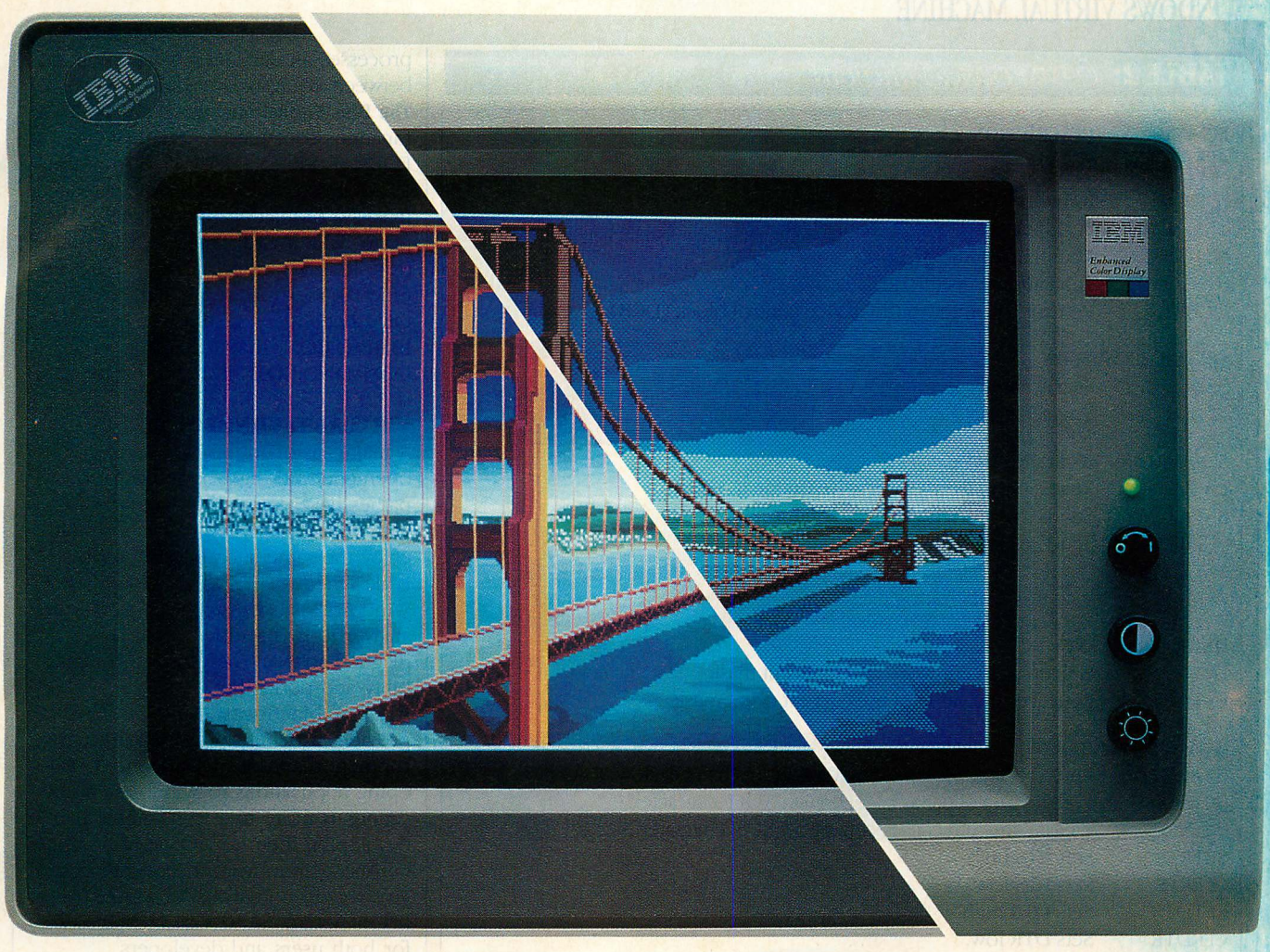
FUNCTION	DESCRIPTION
OUTPUT	
Bitblt	Transfers bits from a source bitmap to an area within a destination bitmap.
Strblt	Transfers pattern for each character in a string from a font bitmap to destination device.
Pixel	Gets or sets the color of the specified pixel.
ScanLR	Scans the device surface in a left or right direction from a given pixel looking for the first match/mismatch of the given color.
Output	General entry point for all line-drawing primitives. Following is a list of all subfunctions that may be implemented by the GDI support module:
Alternate fill polygon	Specifies a polygonal area to be drawn and filled using the alternate filling method (for example, alternating enclosed regions within a complex polygon are filled).
Arc	Specifies an arc is to be drawn.
Chord	Causes an arc to be drawn whose endpoints are connected. The enclosed area is then filled.
Circle	Causes a circle to be drawn.
Ellipse	Causes an ellipse to be drawn.
Marker	Causes one of several selectable symbols to be drawn.
Pie	Causes a pie-type closed arc to be drawn. The arc is drawn, then two additional lines are drawn from the endpoints to the arc's implicit center.
Polyline	Causes a set of line segments to be drawn.
Polymarker	Similar to marker except that it handles multiple market occurrences.
Rectangle	Causes a rectangle to be drawn.
Scanlines	Rapidly fills a set of intervals with the pattern for a particular raster line.
Winding number polygon	Specifies a polygonal area that is to be drawn and filled using the winding number filling method (for example, only enclosed regions within a complex polygon are filled).
ATTRIBUTE	
RealizeObject	Creates a display attribute structure to be used when drawing primitives.
Control	Allows access to the control and escape functions. These functions include:
STARTDOC	Indicates that a new print job is beginning.
ENDDOC	Indicates the end of a job begun by STARTDOC.
NEWFRAME	Indicates that the application is finished writing to the page and should skip to a new page.
SETABORTDOC	Enables the ABORTDOC function.
ABORTDOC	Indicates the driver should abort operation and erase anything written to it since last ENDDOC.
NEXTBAND	Indicates that the application has finished writing to a band (a partial page), causing the device driver to send the band to the spooler and return the coordinates of the next band.
SETCOLORTABLE	Sets internal table with closest approximation to specified RGB value that device can support.
GETCOLORTABLE	Returns an RGB value from an internal color table for the specified index (color).
DRAFTMODE	Turns draft print mode on or off.
GETPHYSICALPAGESIZE	Returns the physical page size.
GETPRINTINGOFFSET	Returns the offset, from the upper left corner of the physical page, where printing begins.
GETSCALINGFACTOR	Returns the scaling factor for the *X* and *Y* axes of the printing device.
FLUSHOUTPUT	Flushes output in the device's buffer.
QUERYESCSUPPORT	Returns information as to escape function availability.
CURSOR	
Inquire	Returns cursor information; specifically mickey-to-pixel ratios for both horizontal and vertical.
SetCursor	Sets cursor shape. If no bitmap is defined (NULL), the cursor is removed from the screen.
MoveCursor	Moves the cursor to specified coordinates. The routine must ensure that the bits under the cursor are restored when moving.
CheckCursor	Is called on every timer interrupt and allows the cursor to be seen if it is no longer excluded.

Functions perform output to devices, create parameters for device specific output, and provide cursor support.

program, and hopes that it will receive control when the program terminates. Users may use the Alt-Tab key sequence to switch between the application and Windows.

An "ugly" application (UglyApp) is one that uses memory directly without requesting that it be allocated. In this situation, Windows saves the state of the machine as best as possible, rolls most of itself out to disk, and turns control over to the application. When the application terminates, Windows attempts to revive itself.

Windows requires two support modules, WINOLDAP.MOD and WINOLDAP.GRB, to assist in running OldApps. WINOLDAP.MOD processes all requests to execute non-Windows applications by preparing memory, and controls execution of the OldApp based on the applications type as defined in the application's program information file (PIF). WINOLDAP.GRB



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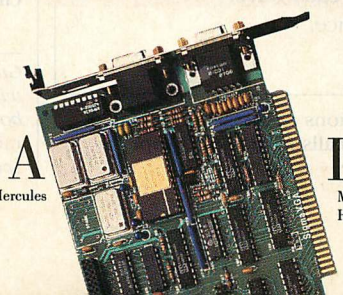
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TABLE 2: *COMM Device Functions*

FUNCTION	DESCRIPTION
SETTING UP DEVICES	
INICOM	Initializes RS-232 port.
TRMCOM	Terminates an RS-232 channel.
SETCOM	Reinitializes RS-232 port.
STACOM	Tests and resets the device status.
DCBPTR	Returns a pointer to the device control block (DCB).
SETTING UP QUEUES	
SETQUE	Sets up queue pointers and initializes queues.
FLUSH	Empties both the transmit and receive queues.
SENDING AND RECEIVING DATA	
RECCOM	Reads a byte from the receive queue if ready.
SNDCOM	Sends a byte to the transmit queue.
SNDIMM	Sends a byte immediately.
SETBRK	Clamps transmitting data line low.
CLRBRK	Releases transmitting data line.
DETECTING EVENTS	
EVT	Sets up an event word and an event mask.
EVTGET	Retrieves the value of the current event mask.
EXTENDED FUNCTIONS	
EXTCOM	Entry point for the extended functions listed below:
SETXOFF	Yields same effect as receiving an XOFF character.
SETXON	Yields same effect as receiving an XON character.
SETRTS	Sets RTS high.
CLRRTS	Sets RTS low.
SETDTR	Sets DTR high.
CLRDTR	Sets DTR low.

Communications functions include setting up devices and queues, sending and receiving data, detecting or ignoring changes in line control signals, and controlling the flow of data. All are necessary to communicate with an RS-232 serial port.

TABLE 3: *SOUND Device Functions*

FUNCTION	DESCRIPTION
OpenSound	Opens access to the play device.
CloseSound	Closes access to the play device.
SetVoiceQueueSize	Allocates space for the specified voice queue.
SetVoiceNote	Queues note information in the specified voice queue.
SetVoiceAccent	Queues voice accent information for specified voice queue.
SetVoiceEnvelope	Queues envelope information for specified voice queue.
SetSoundNoise	Queues noise to noise hardware.
SetVoiceSound	Queues parameters for the specified voice.
StartSound	Starts playing in each voice queue.
StopSound	Stops playing all voice queues.
WaitSoundState	Waits until the driver enters the specified state.
SyncAllVoices	Synchronizes all voices by queueing a sync mark.
CountVoiceNotes	Returns number of notes in a queue.
GetThresholdEvent	Returns pointer to flag word (the threshold event flag).
GetThresholdStatus	Returns the threshold status for each voice.
SetVoiceThreshold	Sets the threshold level for a voice.
DoBeep	Beeps the speaker.

The system speaker module, SOUND, provides all functions necessary to generate sound. There is a one-to-one correspondence between calls available to application programs and functions within the SOUND module.

processes all data-interchange requests between WinApps and OldApps.

The Disk Format Module: MSDOSD. Two functions contained in MSDOSD, FORMAT and SYS, are called from the MS-DOS executive whenever the user makes a formatting request. FORMAT performs a logical format of a specified disk. It also optionally establishes a volume ID after formatting. SYS copies the OEM dependent system files (that is, IBMBIO.COM, IBMDOS.COM, and COMMAND.COM) to a destination disk.

VIRTUAL TECHNOLOGY

A major factor in the PC's success is its open-ended design: hundreds of companies have entered the marketplace with add-on devices. Windows should enjoy the same success because it, too, is designed for new technology. The Windows virtual machine is an elegant answer to two problems that have plagued software developers: compatibility and portability.

Combined with DOS, Windows provides a richer, more uniform environment than does DOS alone. Developing applications to Windows specifications is more time consuming than developing them to DOS specifications, but those short-term inconveniences give way to numerous long-term benefits in system and device independence for both users and developers.

Because Windows and the Windows virtual machine act as an insulating layer between applications and DOS as well as between applications and hardware, applications developed to Windows' specifications should be immune to differences and upgrades in DOS and in hardware. Thus, Windows applications will have the built-in independence necessary to take advantage of technological advances in systems, devices, and operating systems.

Microsoft Corporation
16011 N.E. 36th Way
P.O. Box 97017
Redmond, WA 98073-9717
800/426-9400; 206/882-8080
Windows 1.04: $99
Windows Software Development Kit: $500
Adaptation Kit: no cost addition to the Software Development Kit (non-disclosure agreement required)

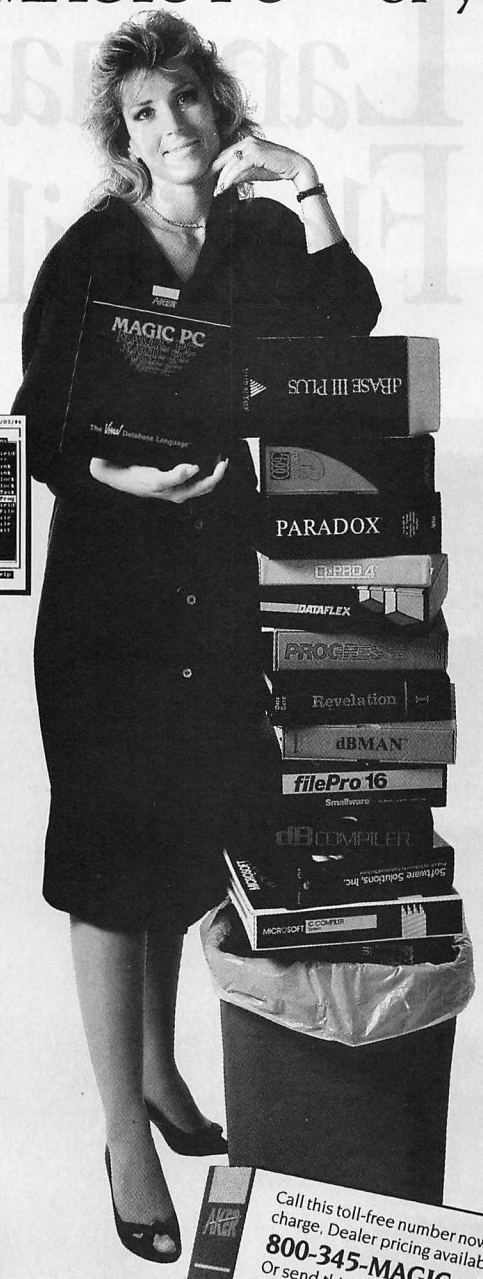
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Guy Quedens is a systems software engineer with Xerox Corporation. His forthcoming book, Introduction To Windows Programming, *is to be published in Winter, 1987, by Scott, Foresman and Company.*

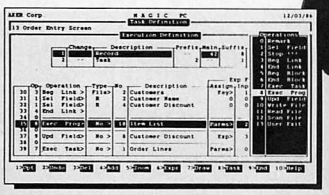
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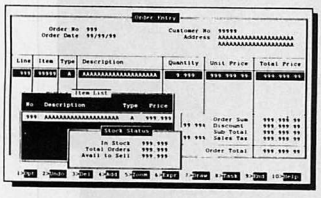


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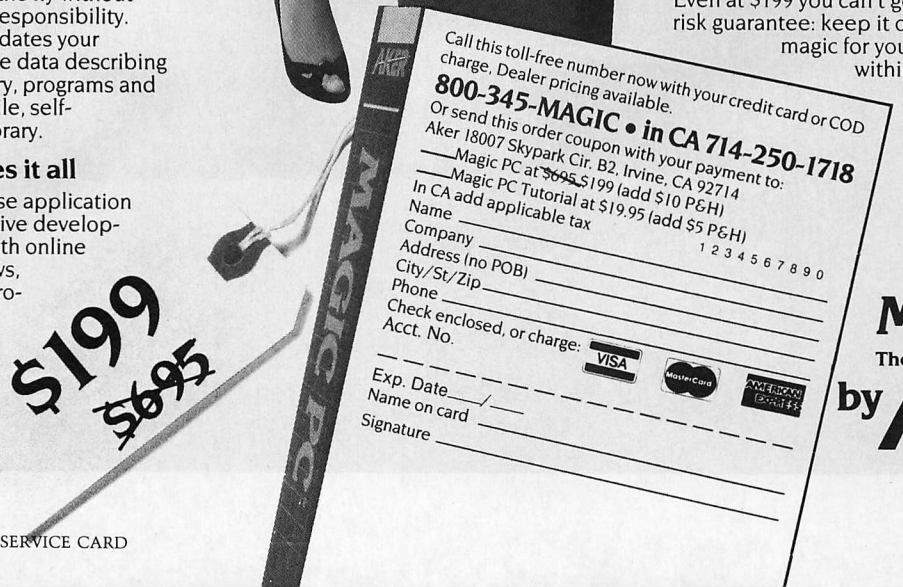
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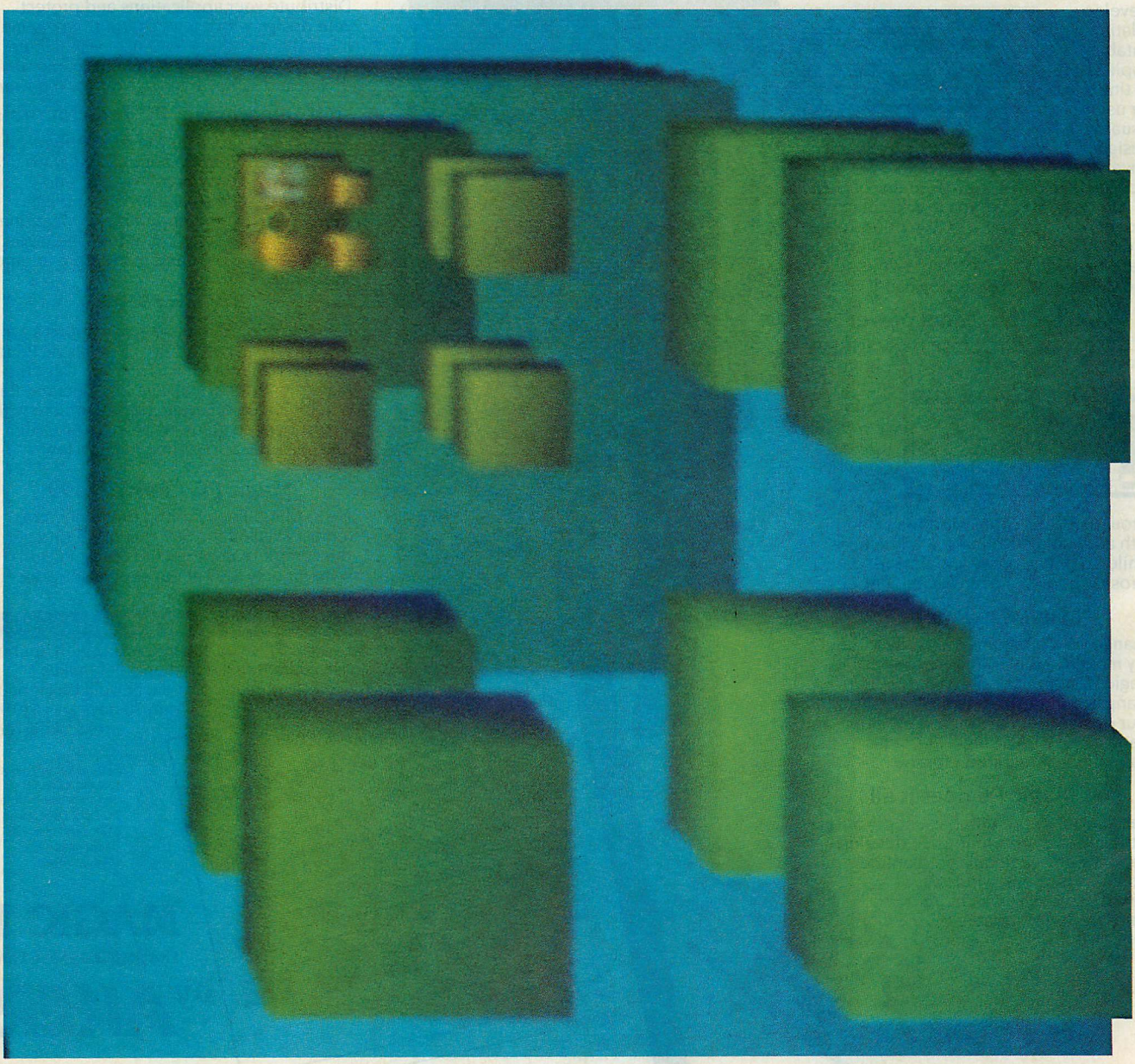
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A Data Manager with Language Flexibility



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Unlike most data managers, SoftCraft's Btrieve lets programmers work in their favorite language. Xtrieve adds query and report capabilities to the package.

BURKS A. SMITH

When it was first introduced in 1982, Btrieve's claim to fame was its ability to work with a familiar programming language—BASIC, C, COBOL, or Pascal. This freed the software developer from the burden of learning a whole new language designed specifically for a database. Since then, SoftCraft has widened the arena for its product by teaming Btrieve with a companion product called Xtrieve that adds query and report capabilities to the package.

A third product, XQL, not released in time for this review, will expand the capabilities of the package further by providing relational data access and query features to programs using Btrieve. It will also let developers incorporate structured query language (SQL) statements into applications and query the database interactively in SQL.

Like most SoftCraft products, Btrieve and Xtrieve are marketed primarily to software developers, either directly or through mail-order houses. They are not copy protected and have no licensing fee when distributed as part of an application. Both are available in either DOS or XENIX versions.

Btrieve is a memory-resident program that manages keyed file access from programs that are written in any of several popular languages. It is accessed through compatible interface routines that are designed specifically for these languages. A complete record-management system, Btrieve provides multikey access to records; relational access among files; support for duplicate, modifiable, segmented, and null keys; security and integrity controls; multiuser access; and utilities for creating and maintaining files.

It comes on a single diskette that contains the Btrieve program itself; a BUTIL utility program providing general-purpose file creation and maintenance routines; a library of linkable object-code interfaces for different languages; and interface source code for several popular C and Pascal compilers. Btrieve also provides utilities to extend a file across two logical disk drives, to recover a damaged Btrieve file, to report characteristics of a file, and to stop Btrieve and return memory back to the operating system.

Btrieve requires either MS-DOS, PC-DOS (2.0 or later), or XENIX, and at least 128KB of memory. The record manager alone uses 32KB; because of this relatively small overhead, Btrieve easily can be included on a diskette with the developer's application.

Xtrieve is a menu-driven query and report-generation program that requires Btrieve for file access. According to SoftCraft, the primary market for Xtrieve is as a supplemental module for generating ad hoc queries and comprehensive reports in applications written by developers using Btrieve.

End users who maintain relatively simple databases and who would rather not learn a separate database language may be attracted to Xtrieve. Although it does not have all the features users have come to expect in database management systems, its menu-driven design and adequate on-line help serve to soften the learning curve.

SoftCraft delivers Xtrieve on two diskettes, plus a third if the Report Option is purchased. The program diskette includes files for the program, help, messages, configuration, and menus. A utility diskette contains programs for managing menus and command files, plus sample databases and tutorials. The Report Option diskette contains the report module, plus additional examples and tutorials.

Xtrieve requires MS-DOS or PC-DOS (2.0 or later), at least 256KB of memory, and Btrieve. It occupies all but about 3KB of a 360KB diskette, not including Btrieve; although it can run on a diskette-based system, it probably is better suited to a hard disk.

The user installs both Btrieve and Xtrieve simply by copying the programs and configuration files from the distribution diskettes to the application disk or diskette. No installation program is included.

MANAGING DATA WITH BTRIEVE

Btrieve provides the underlying structures for a relational database that links information in one file to information in another by a *relation*, or information common to both files. This avoids the need to duplicate data already present in another file.

With most database managers, the relationship between files is automatic once it has been established—the related files are kept synchronized by built-in procedures. With Btrieve, however, the application program is required to provide the necessary housekeeping functions. This involves using a field from a primary file as a key to access a secondary file—with all of the associated error handling that this operation encompasses. SoftCraft claims that this shortcoming will be corrected in its new XQL product.

File structure. A Btrieve file is stored in a special format that contains both the data and the permanent indexes. These

TABLE 1: *Data Types Supported by Xtrieve*

NAME	SIZE (bytes)	DESCRIPTION
String	1–256	Any printable ASCII data. Fixed-length field.
Integer	1, 2, or 4	One-byte integers are unsigned bytes with values from 0 to 255. Two- and four-byte sizes are signed integers of the bit size specified.
Float	4 or 8	IEEE standard representation of signed real numbers.
Date	4	Displayed in the form mm/dd/yy. Internally stored as a 1-byte day, 1-byte month, and 16-bit year in the range 1900–2099.
Time	4	Displayed as hh:mm:ss. Stored as hundredths of seconds, seconds, minutes, and hours; each one is 8 bits long.
Decimal	Any	Packed decimal with a fixed, implied decimal point. Compatible with the COMP-3 data type in ANSI-74 COBOL.
Money	1–10	Displayed with a floating dollar sign. Internal format is the decimal type with two digits to the right of the decimal.
Logical	1 or 2	0 represents false, nonzero represents true.
Numeric	1–15	A right-justified ASCII representation of a signed number with an optional fixed decimal point. The sign is coded on the last digit.
Bfloat	4 or 8	A real number compatible with Microsoft BASIC single and double precision.
Lstring	2–256	A Pascal-compatible string where the first byte contains the binary string length.
Zstring	2–256	A C-compatible string where the string is terminated by a binary zero.

Xtrieve supports string, logical, and numeric data types including several special forms such as date, time, and money. Btrieve is unconcerned with data types.

indexes must be defined at the time that the file is created.

Files are organized in *pages* of user-defined lengths. A *header page* contains the page size, record length, current number of records in the file, and tables describing each index. Btrieve reads this header page when the file is opened to obtain the file's characteristics for use in processing the file. *Data pages* store blocks of records, with as many records as possible filling a page. *Index pages* store lists of each record's key fields along with the data and index pointers needed to maintain the indexing scheme. As a file grows, more pages are allocated automatically.

Btrieve supports both fixed- and variable-length records. Record-length limits are closely related to page sizes, which are Btrieve's unit of disk access. Page sizes can range from 512 to 4,096 bytes, in 512-byte increments; each page consists of one or more records and several bytes of overhead.

Because records cannot be split between pages, the programmer must choose a combination of page size and record length that results in efficient storage. Although as few as 6 bytes are required for overhead, two 512-byte records cannot fit on a 1,024-byte page; records of this length would waste nearly 50 percent of the page space. By using a slightly shorter record length or a larger page size, storage efficiency improves dramatically.

The maximum page size is 4,096 bytes; thus, the maximum record size is 4,096 bytes minus the page overhead, which varies according to how keys are defined. For microcomputer applications, Btrieve places no effective limit on the number of records that can be stored in a file. Files can hold up to 4 billion bytes and are restricted only by the limits of the physical media and the operating system. Btrieve can even extend a file across two disk drives.

Because Btrieve has no programming language of its own, it imposes no restrictions on the number and types of fields included within a record. This allows the developer to store data efficiently in the native format of whatever language is being used. With Xtrieve, however, data types are restricted to the types that are supported by Xtrieve (see table 1), and fields used as indexes should be formatted for correct sorting.

Indexes and keys. Btrieve allows the user's program to store and retrieve data reliably in indexed files. Access to these files can be random by key, sequential by key (forward or backward), or direct by record number.

As its name implies, Btrieve uses the binary-tree indexing scheme. It indexes files automatically and invisibly, based on key values in the records being added, deleted, or updated. Btrieve maintains a separate index for each key field defined and stores records in ascending order of key-field values. It permits more than one index per file so that data in the file can be accessed in different ways, as required by the application.

The user can define up to 24 key fields for one Btrieve file. A key field can be an individual key or a segment of a key containing several fields. A single key can be defined with up to 24 fields, 24 separate keys, or any combination in between. The maximum length of an individual key field cannot exceed 255 bytes, which is limited to the file's record length.

A key field can be collated as either a string or a binary integer. Strings are compared byte-by-byte from left to right, while binary integers are compared as unsigned quantities word-by-word from right to left in the format used by Intel microprocessors.

Switches specify either an ascending or a descending sort and determine whether a key is segmented, null, modifiable, or a duplicate. A segmented key can have more than one field value with up to eight segments. For example, a segmented key might consist of a person's last name and first name, so that reports could be sorted on the basis of either name.

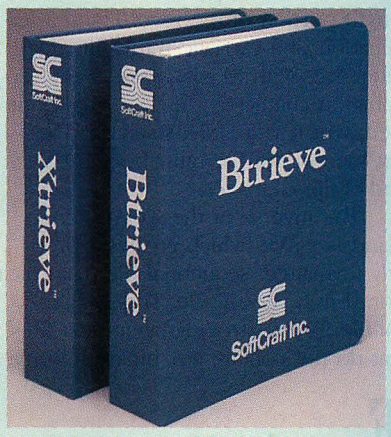
Null keys contain user-defined null values, usually an ASCII blank or binary 0, and are used to improve performance during a search for nonblank values and prevent the use of nonessential information. For example, for a null key defined as a field of blanks, no indexes would be generated for an empty "ship to" field in an invoice.

File definition. The easiest way to create a Btrieve file is to use it in conjunction with Xtrieve, which allows the user to design file formats on the screen, as would be expected in most data managers. When Btrieve is used alone, however, its BUTIL utility program creates and maintains the files. The programmer first prepares a *description file* using a text editor. This file includes lists of key words (lowercase only), each followed by an equals sign and parameters describing the file's characteristics. By current software standards, this is a Stone Age approach;

OVERVIEW OF BTRIEVE AND XTRIEVE

BTRIEVE, version 4.03
XTRIEVE, version 3.0
SoftCraft, Inc.
P.O. Box 9802 #917
Austin, TX 78766
512/346-8380
CIRCLE 340 ON READER SERVICE CARD

Product description. Btrieve is an indexed file-management system with interfaces to popular languages, including BASIC, C, COBOL, and Pascal. Its companion product, Xtrieve, is a menu-driven relational query and report-writing package.
IBM PC environment. Both Btrieve and Xtrieve run under MS-DOS or PC-DOS version 2.0 or later. Btrieve requires a minimum memory of 128KB; Xtrieve requires 256KB. Color video is supported, but graphics are not required. A hard disk is recommended for larger applications.
Other environments. XENIX.
Network support. Optional multiuser version supports most popular local area networks under DOS 3.1.
Copy protection. None.
Documentation. Separate, well-organized manuals for both Btrieve and Xtrieve are provided in slip-case binders. Xtrieve also includes an effective tutorial that is implemented in Xtrieve's command file structure.
User interface. Xtrieve is fully menu-driven with overlapping pop-up menus. Menu selections are made by highlighting with the cursor-movement keys or by entering the first letter of the description. If a menu contains more entries than can fit in the window displayed, the selections scroll. Facilities are provided to create custom menus and descriptive help-text screens. When used with a color-video interface, color enhances the readability of the screens. The actual colors used can be modified through the configuration feature.
Help facilities. Each menu selection in Xtrieve is individually described by one line of text located on line 25 of the screen. This description automatically changes as each selection is highlighted. A comprehensive explanation of the current menu's functions is available simply by pressing a function key. Help text is accessible to the developer and can be customized through utility programs that allow editing the system's help file.



File capacities. Both Btrieve and Xtrieve support any number of files to be included in a database, subject to operating system constraints. Each file can contain an unlimited number of records, and a utility is provided to extend a file across disk drives. Maximum record length is 4,096 bytes. Up to 256 fields may be specified per record. A maximum of 24 indexes are stored with the data. If a key has more than one field, each field counts as an index. A file must contain at least one index.
Fields and capacities. Twelve data types are provided, including types compatible with BASIC, C, COBOL, and Pascal. Maximum field length for strings is 256 characters.
Data entry. Only simple add and edit facilities are provided in Xtrieve. All built-in data entry and editing are accomplished spreadsheet style. With Btrieve, the developer's choice of language must be used to create custom data-entry screens and to perform validation and table look-up.
Application development facilities. Because Btrieve has no built-in language, developers must use another language for application development. Xtrieve has a record and playback command facility to store and recall the keystrokes necessary to set up files, views, and reports.
Security. Access to Btrieve and Xtrieve files can be restricted by an eight-character owner identification, with optional encryption of data.
Access to system facilities. Xtrieve's RUN command allows access to all DOS facilities and external programs.
Query and sorting. In Xtrieve, data files are created with permanently defined indexes, automatically updated. Views can be defined to contain fields from several files or user-defined fields derived from one or more fields in the database by means of a formula. A view can be restricted to records meeting specified criteria. Files can be indexed temporarily on fields other than those defined in the permanent index.
Reporting. The extra-cost Report Option provides facilities for generating a wide variety of reports, including multiple report forms per page—such as labels. Pages can include headers and footers. Multiple levels of control-breaks can be defined, and the system computes the count, sum, average, maximum, and minimum value of a field. User-defined fields are specified as part of a view, which may reference several physical files.
Utilities. Btrieve has utilities for defining files, uploading and downloading data, and recovering data from damaged files. Xtrieve's utilities are for editing command files and help text.
Data compatibility. In Xtrieve, data can be imported in three formats: DIF, the data interchange format used for many spreadsheets; SDF, the program's term for a comma-delimited format; and unformatted, fixed-length fields and records that can contain binary information, but must be terminated by a carriage return.
Distribution. SoftCraft markets its products directly to software developers or through mail-order distributors. Xtrieve is sold primarily to clients of developers using Btrieve.
Price. Btrieve: $245, single user; $595, multiuser. Xtrieve: $245, single user; $595, multiuser. Btrieve is required for Xtrieve. Xtrieve Report Option: $145, single user; $345, multiuser.
Support. All registered users who return the program's registration card receive 30 days of free telephone support from SoftCraft. A customer number is required in order to receive support. After the 30-day period, direct-connect support costs $150 per year. For $50 per year, a separate plan, the Btrieve Update Service, entitles subscribers to an update diskette whenever new versions are released. Finally, the company maintains a free electronic bulletin board service on evenings and weekends to distribute information to its users.

—Burks A. Smith

but Btrieve's intended users—programmers—should be familiar with the procedure.

For the file as a whole, the description key words are

```
record = <record length>
variable = <variable length records (y/n)>
key = <number of keys>
page = <page length>
```

For each key segment (up to 24) the key words required are

```
position = <field offset into record>
length = <field length>
duplicates = <duplicate keys allowed
             (y/n)>
modifiable = <keys may be modified
             (y/n)>
type = <binary/string>
alternate = <use alternate collating
          sequence (y/n)>
null = <a null key (y/n)>
value = <if a null, the hex value of the
        character>
segment = <another segment follows
          (y/n)>
name = <if alternate, the name of a file
       with the table>
```

The alternate-sequence file allows Btrieve to sort text information in other than the straight-ASCII collating sequence. This file consists primarily of a 256-byte table containing translation values for the ASCII codes in the key itself. One alternate-sequence file, UPPER.ALT, provided on the Btrieve diskette, specifies that both upper- and lowercase letters have the same sort value, which is a necessary feature when alphabetizing. Another use for an alternate-sequence file, for example, might be a foreign-language collating sequence that places the foreign characters of the PC's character set in correct order with the rest of the alphabet.

Once the description file has been built, BUTIL is invoked from DOS with

```
BUTIL -CREATE  <file name>
  <description file>
```

where **<file name>** is the name of the Btrieve file to be created and **<description file>** is the name of the description file. This creates an empty file, ready to receive data.

Data records are added to the newly created file through the application program or BUTIL's -LOAD option, which loads a file from an external sequential file using the command

```
BUTIL -LOAD  <input file>
  <Btrieve file>
```

Unfortunately, the load utility cannot handle standard data formats; instead, the input file must be in a special format consisting of an ASCII record length, a space, the actual fixed-length data record, the optional variable-length portion of the record, and a termination of a carriage return/line-feed sequence. With XENIX systems, the termination character can be a single line feed, which is a UNIX standard. The last byte in the file must be a 1AH end-of-file character.

The inverse of the -LOAD command is -SAVE, which creates a properly formatted, sequential file from data stored in a Btrieve file. This sequential-file format strongly favors text files that do not contain any binary information; and the Btrieve manual warns against attempting to process files that include binary information with programs that expect text, such as text editors and word processors. These programs may incorrectly interpret an end-of-file mark embedded in a data field as the actual end of the file and dump the rest of the data.

Even when Xtrieve is not required, it is extremely valuable during development for its file creation and data-transfer utilities.

Xtrieve provides a much easier way to load and save data with its translate facility, which supports common data formats without any special formatting. Even when Xtrieve is not required for the application being created, it is extremely valuable during development for its file-creation and data-transfer utilities alone.

Btrieve does not have a mechanism for changing record lengths or field layouts. In order to add or delete fields or to change their length, the developer has to write an appropriate conversion program.

Because Btrieve keys are stored in the same file with the data, they are more difficult to change than in data management products that store indexes in separate files. If the file must be indexed by key fields that were not defined at the time the file was created, the developer can either generate an external index or reorganize the primary Btrieve file with different keys. BUTIL provides both these functions.

To reorganize a file, BUTIL's COPY command copies data from an existing Btrieve file to a new file having different key definitions; these, like the originals, become permanent indexes.

A temporary index may be preferable for producing an infrequent report or performing some special processing. To construct a temporary index, the INDEX command creates a Btrieve-format data file containing the primary file's temporary index field(s) and the binary-record address of the target record in the primary file. To access records using the new key, the programmer reads the temporary index file of the desired key to obtain the record address. A direct read of the primary file then yields the data.

An external index file is created with the command

```
BUTIL -INDEX  <Btrieve file>
  <index file><description file>
```

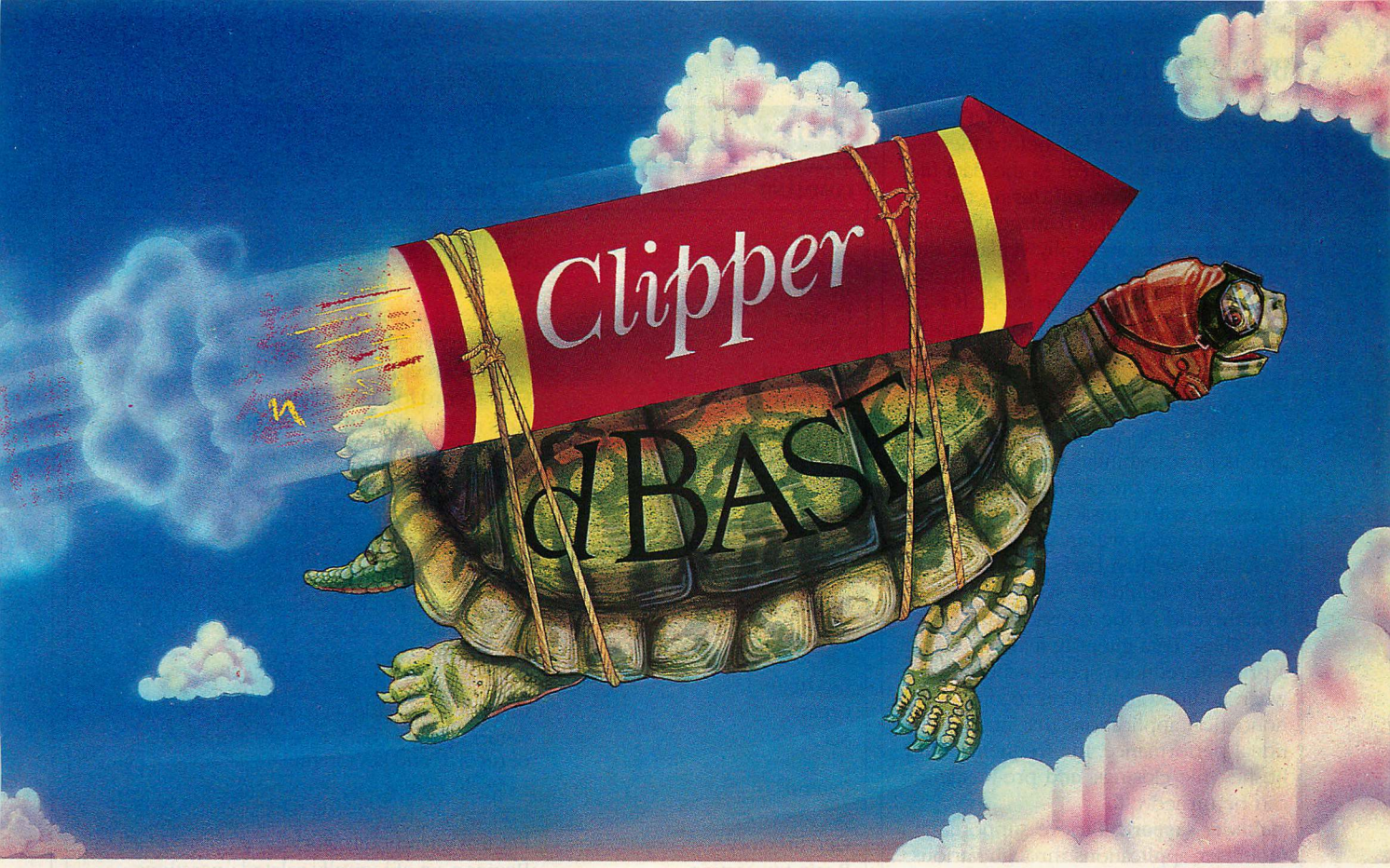
The description file of the temporary index file contains key descriptions in the same format that the description file required for creating a new file; the index utility, however, calculates the header-page information. Because the temporary index file is not linked in any way to the primary file, it becomes obsolete as soon as any changes are made to the primary file. To ensure maximum database integrity, temporary indexes should be limited to read-only accesses.

Security and integrity. Btrieve files have an eight-character owner name stored in the file's header page. If a programmer does not use this name when opening the file, Btrieve refuses access.

To secure a file, the application executes the Btrieve SET OWNER command, giving the eight-character owner name as a parameter. The command includes options to allow read-only access and to encrypt the data for extra security. Without data encryption, Btrieve denies file access only to an application using Btrieve; but the data could still be read using non-Btrieve methods, such as a debugger. If data encryption is specified, all existing records in the file are encrypted using the owner name as a key and cannot be deciphered using ordinary techniques.

Btrieve has several data integrity enhancements. It writes buffers to disk frequently, and it briefly closes files after a file's size has increased by a new page in order to assure that no data are lost in a power failure.

Integrity is further enhanced by a pre-imaging technique; whenever a file is updated, the original image of the



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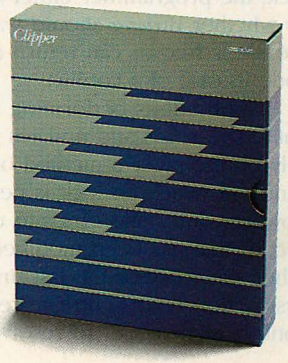
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page from the file is written to a temporary .PRE file on disk before the updated page is written to the data file. If the system should fail during the update operation and damage the data, then Btrieve automatically replaces the damaged page of data with its original image when the system restarts. If a file is too badly damaged to recover automatically, then BUTIL's RECOVER command extracts the data and places them in a sequential file.

Btrieve also provides transaction-processing capabilities to enhance integrity. Btrieve operations can be bracketed with transaction BEGIN and END commands within the program code. Btrieve then backs out of any transaction should the system fail before the end of the transaction.

These data-integrity features extract a price in reduced speed, especially when adding or updating records. For noncritical applications that need additional performance, the frequent buffer flushes, file closings, and pre-imaging can be turned off.

Multiuser support. Btrieve supports multiuser applications through various concurrency methods, including transaction control, passive concurrency, and record locking. With transaction control, the application issues a BEGIN TRANSACTION command before actually accessing the data. During the transaction, the entire file is locked for updating by that station. Other stations can still read the file if the reads are not embedded in a transaction. The file remains locked until an END TRANSACTION command is issued.

A transaction can include any number of Btrieve operations and up to 12 different files. Btrieve performs *wait locks* by default, making a station wait until the file is free before completing the requested operation. However, the manual warns that wait locks have the inherent danger of creating a deadlock in which two stations can lock each other out of different files if the stations are accessed out of order. This would require a restart. To avoid deadlock, the programmer either can specify whether Btrieve should wait until the file is free or can return a busy code in case of a conflict.

Applications performing independent single reads and updates should rely on the passive method of concurrency, in which no lock is performed; however, if a station tries to update a record that has been modified by another station since the last time the first station read it, Btrieve returns a conflict error code. To resolve such conflicts, the application must detect the error and reread the record before permitting an update.

The passive method of concurrency can be combined with transaction control. Because stations using the passive method do not obtain a file lock, they can read records from a file that has been locked by transaction processing from another station. However, if they try to update a record, Btrieve forces them to wait until the other station's transaction has been completed. This allows one station to perform a transaction-oriented posting operation, for example, while still allowing other stations to make queries.

Btrieve applications also have the ability to lock records one at a time. While a record is locked, other stations can read it, but they cannot update it. A record lock releases automatically whenever the locking station updates or deletes the record, locks a different record, or closes the file.

TABLE 2: *Btrieve Command Summary*

COMMAND	DESCRIPTION
Open	Opens file
Close	Closes file
Insert	Inserts new record into file
Update	Modifies current record
Delete	Deletes current record from file
Get equal	Retrieves record of specified key
Get next	Gets record following current one
Get previous	Gets record preceding current one
Get greater	Gets record with key value greater than the specified key
Get greater or equal	Gets record with key value greater or equal to the specified key
Get less than	Gets record with key value less than the specified key
Get less than or equal	Gets record with key value less than or equal to the specified key
Get lowest	Gets record with lowest key value
Get highest	Gets record with highest key value
Create	Creates Btrieve file with specified characteristics
Stat	Returns a file's characteristics, number of records and keys in file
Extend	Extends a file across two drives
Set directory	Changes current directory
Get directory	Returns current directory
Begin transaction	Begins a set of logically related operations
End transaction	Ends a set of logically related operations
Abort transaction	Removes operations performed during an incomplete transaction
Get position	Gets position of the current record
Get direct	Gets the record at a specified position
Step direct	Gets record in the physical location following the current record
Stop	Terminates the record manager
Version	Retrieves current Btrieve version
Unlock	Unlocks a locked record
Reset	Releases all resources held by a station
Set owner	Assigns an owner name to a file
Clear owner	Removes an owner name from a file

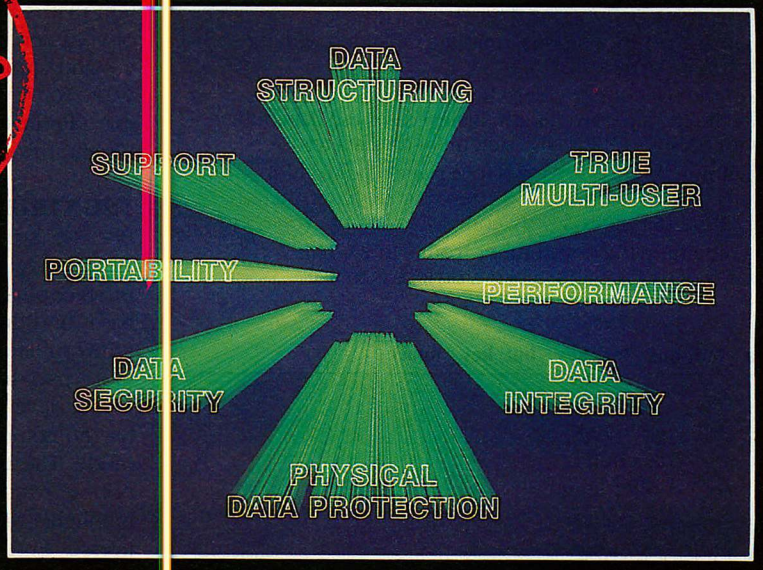
Btrieve provides 31 operations that can be called as subroutines from the languages supported. With compiled languages, these subroutines are linked with the application. With interpreted BASIC, the interface is memory resident like Btrieve.

NO-FRILLS PROGRAMMING

Communicating with Btrieve is not complicated for an experienced programmer. With compiled languages, the interface consists of a function or subroutine that is linked with the application. (See table 2 for a list of Btrieve operations.) With interpreted BASIC,

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TABLE 3: *General Form for a Btrieve Comman*

FROM BASIC:
CALL BTRV (OP%, STAT%, FCB%, BUFLEN%, KBUF$, KNBR%)

OP%	The Btrieve operation code. An integer from 0 to 30 specifying which operation is to be performed.
STAT%	A status variable that the program should check after the call to determine whether the operation was successful.
FCB%	The address of BASIC's file control block, which Btrieve uses to maintain its file positioning information. Obtained with the VARPTR (#FILENO) function.
BUFLEN%	The length of the data buffer where Btrieve is to find or place data. Usually the file's record length. Btrieve uses the data buffer allocated with BASIC's OPEN NUL statement for data transfers.
KBUF$%	A string containing key to be passed to Btrieve. The developer must format the string to match the way Btrieve has stored it, including concatenating segmented keys, converting to uppercase, etc.
KNBR%	An integer containing the key number from 0 to 23. This specifies which of the possible 24 keys Btrieve is to use.

FROM C:
int BTRV (op, pos_blk, data_buf, buf_len, key_buf, key_num)

```
int op;              /*  operation code   */
char pos_blk[ ];     /*  position block   */
char data_buf[ ];    /*  data buffer      */
int *buf_len;        /*  buffer length    */
char key_buf[ ];     /*  key buffer       */
int key_num;         /*  key number       */
```

Btrieve can be called from most popular programming languages including BASIC, C, COBOL, and Pascal. The general form for a subroutine call to Btrieve is similar in BASIC and C. Each operation has a specification code that is passed in first, followed by a list of the parameters that are needed to complete the operation.

the interface is memory resident like Btrieve itself. To access a record, the developer's program passes the appropriate command code, the address of a buffer where Btrieve is to store or fetch the data, the desired key, and several control parameters. When the operation is complete, Btrieve returns a code indicating either the success of the operation or an error.

The general form of a Btrieve command varies slightly depending on the language being used. Table 3 provides examples in BASIC and C. The C function is exactly the same as the BASIC function, except the function *returns* the integer-status code, and Btrieve must have a 128-byte array for housekeeping in lieu of BASIC's file-control block. Calling sequences in Pascal and COBOL are similar. Access using assembly language is possible.

A program developed to list the *PC Tech Journal* test file of authors was written in PC BASIC. Because the BASIC interpreter was used, the interface routine is a memory-resident program that, when initially executed, writes its segment address to a disk file so that the application knows where to find it. The BASIC program reads the interface routine's segment address from the file and uses it in a DEF SEG command, which sets BASIC's segment-address pointer before calling Btrieve as a machine-language function. This is an effective way to access an external program using BASIC, but the user must take care to ensure that the file containing the interface segment is always from the current resident-interface routine, rather than from an old session. If the program finds the file—and the interface routine has not been loaded—the call sends the processor to never-never land.

These dangers are not present with most compiled languages, where the interface routine is linked with the application. By using the linkable object modules that are included with the system, Btrieve can be operated with compiled languages.

Except for direct support for relational databases, a shortcoming the new XQL reportedly will correct, very little is missing from Btrieve in the way of basic file-management functions, but the fancy frills are left to the programmer. Btrieve is a complete way to maintain and access indexed files from the programmer's favorite language.

Because of this lower-level access, programs tend to be longer than if a database management system with a built-in language were used. However, programs can be customized for any purpose. The only limitations depend on the time and talent of the developer and the requirements of the client. In fact, Btrieve is the file-management system that is incorporated into a variety of commercially available data managers and application packages, such as MAGIC PC (reviewed in "A Data Manager that Eliminates Programming," Victor Wright, this issue, p. 124).

THE XTRIEVE SHELL

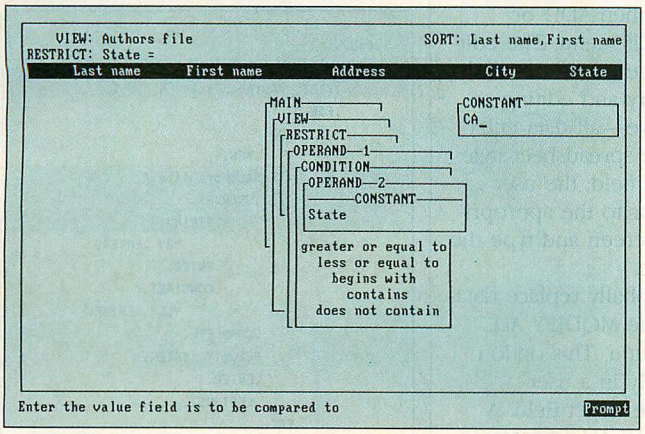
Because Xtrieve is primarily a back end for Btrieve, it has all the features of Btrieve, plus it supports relational databases and duplicates many of Btrieve's utility functions in a way that is much more user friendly.

Xtrieve is entirely menu driven; it has no commands and no expert mode. The user interface is the familiar pop-up window menu where the user highlights the desired selection and presses Enter. The user selects functions by the eight standard cursor-control keys, which perform as expected. As a shortcut, pressing a single letter highlights the next sequential menu entry that begins with that letter.

In many cases, a selection from one menu leads to another menu—sometimes three or four levels' worth of menus. Navigating these levels can be cumbersome and prone to error. However, Xtrieve has a logical menu placement, with each successive menu's window one line down and one row to the right of the previous menu (see photo 1) to help the user keep track of where he is. The Esc key terminates the current menu or operation and returns to the next higher-level menu.

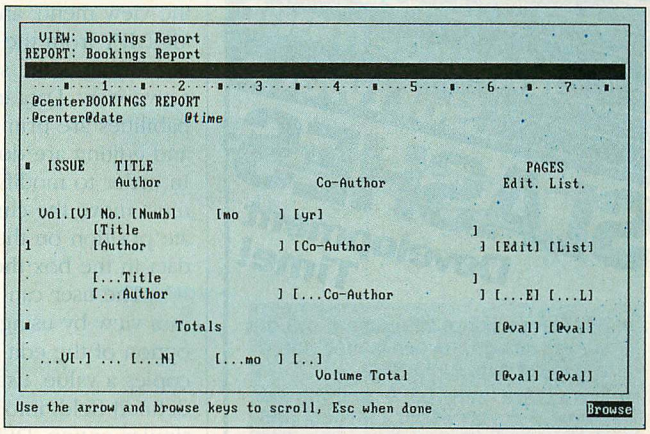
Xtrieve's main menu contains eight selections: VIEW, REPORT, QUIT, HELP, COMMANDS, CONFIGURE, RUN, and DICTIONARY. The DICTIONARY selection displays a second menu containing options to display a file definition, define a new file, modify a file, define default values, remove a file from the dictionary, and create a new dictionary. To create a new file, the programmer chooses DEFINE from the dictionary menu and a new file is defined interactively. The programmer gives the file a descriptive name that will appear on menus, and a location name, which is its DOS file name on disk, conforming to DOS naming conventions. Each field is named and assigned a data type and a length.

PHOTO 1: *Menu Structure of Xtrieve*



In the sample application, several menu selections are required in Xtrieve to define a restrict clause to select a view that contains only those authors who live in California.

PHOTO 2: *Report Option Form*



In a report form, field names are bracketed and positioned as they will appear. Names preceded by periods indicate that the field is to be repeated; @ signs indicate functions.

Because Xtrieve has no language of its own, field names are used only as menu selections and therefore do not have to conform to the requirements of a specific interpreter or compiler. Phrases such as "City, State, and Zip" are perfectly acceptable as field names. However, all field names must be unique to the data dictionary, even if they appear in different files. Like all Btrieve files, one or more of the fields in a record must be specified as a permanent key field at the time the file is created. Xtrieve's file capacities are the same as for Btrieve, with no specific restriction on the number of files that may be defined or the number of fields allowable per record.

The developer must specify all the keys to be used by the application in any procedure that performs file updates. If some keys are left out, a temporary index file can be created later, but this slows operation and does not allow the file to be updated. In addition, if files are to be related, an index must be provided for the relationship needed to join the files.

The data dictionary itself is composed of several Btrieve format files that separately track files, fields, indexes, defaults, and, optionally, the owner identification. In fact, the dictionary files themselves can be defined in the data dictionary and accessed with any Xtrieve operation. This is a convenient way to view data formats or generate reports of file formats.

A file format can be changed from within Xtrieve, but only the definition is affected, not the data file itself. If fields are added, deleted, or changed in length, Xtrieve can no longer accurately read the data in an existing file. If a file must be reformatted, say to add a field, a temporary view of the file must be created that contains the new field as a user-defined constant or a calculated amount from other fields. This view must then be written to disk in an ASCII format and reloaded into the new file format. This is a rather time-consuming process, but the tools are provided from within Xtrieve.

Unlike Btrieve (which is unconcerned with data types except in key fields), Xtrieve supports 12 data types, including 3 types of strings and 6 types of numbers, plus date, time, and logic. Many of these data types are compatible with specific language formats used in BASIC, C, COBOL, and Pascal, so Xtrieve can be used with files that are created by a Btrieve application using one of these languages.

A VIEW FROM THE MENU

After creating a file, the programmer must define a *view* before accessing the file. A view is simply columns of fields and rows of records; it looks and acts like a spreadsheet, except that calculations are limited to user-defined fields.

The VIEW option on the main menu provides Xtrieve's data-manipulation capabilities, such as selecting a file to view or to join to the current view, sorting and restricting records, browsing, and so on. The default view contains all the fields in the order they were defined, but the user can select and rearrange this order, change titles, and create new fields from formulas involving other fields or constants.

Views also can be relational. Once a primary file has been specified, the system can *join* one or more secondary files to the view. It does so by using an existing field in the primary file as a key to accessing the secondary file; the programmer must define this key field as an index when it is first created. After the secondary file has been selected, its fields are added to the list of available fields for the view. The primary and secondary files appear to be the same file in the view.

The last two elements of a view are *sort* and *restrict*. The sort determines the order in which the records appear. If the sort is user-defined, it cannot be updated.

The restrict attribute causes the system to ignore all records that have not met certain criteria. For example, a restrict clause may specify that only records with a certain abbreviation in the state field be included in the view.

Like all Xtrieve functions, restrict clauses are formed interactively—the user selects choices from a menu, entering constant information as required. These clauses can be complex; as the user builds a clause, a formula appears in the top window of the screen, but the user cannot edit this formula. The only recourse in case of a mistake is to abort the operation and start over.

Once a view has been established, the user can name and save it to disk by invoking the MANAGE option from the view menu. The names of previously saved views appear on the recall menu and can be retrieved at any time. Xtrieve allows the user to define up to four different views during a single session, although only one view can be active at one time. The user can switch among the views as needed.

A BROWSE option on the view menu enables the user to see the data as defined by the view, but does not

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  - release_form ( )
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  - put_field ( )
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  - get_field ( )
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allow any changes. The user enters and updates data by selecting EDIT from the view menu, and then ADD or MODIFY from the edit menu. The editing format is the same as the currently active view. Data entry and editing capabilities are primitive—all data entry and editing are done spreadsheet-style. In order to modify a field, the user must move the cursor to the appropriate position on the screen and type the data in the box there.

The user can globally replace data in a view by using the MODIFY ALL option of the edit menu. This option copies a value, usually in a user-defined field, into the target field. A similar option, DELETE ALL, deletes either all records in a view or only those records that meet certain criteria.

Data can be analyzed in a view by computing summaries in one or more fields. These summaries are limited to count, sum, minimum, maximum, and average, but they can be applied to a user-defined field generated from a more complex formula.

For data entry, Xtrieve users must rely on Btrieve and their chosen programming language. Xtrieve has no facilities for designing custom screens and no way to perform verification procedures during data entry. All fields from a specific record are displayed on the same line, as defined by the view. If the record has more fields than the screen can display, the entire screen scrolls to bring the fields into view. A view that contains joined files or a temporary index cannot be edited.

Although Xtrieve does not have a programming language, it allows the user to *record* and *play* the keystroke sequences for a specific operation, create user menus, and display text windows using the COMMAND option. To record, the user presses a function key and specifies the name and description of the file that is to contain the recorded keystrokes. The user then performs the desired operation and presses a function key to terminate the recording process.

In subsequent sessions, the user can play back this named keystroke sequence, eliminating the multitude of menus. In the default playback, Xtrieve makes an audible beep each time a keystroke is executed—a little less than once a second on a PC/XT. Options are available to speed up or slow down the playback or to make it invisible.

The user can edit playback files using two methods. One way is in single-step editing mode by pressing the record function key at the point where new keystrokes are to be recorded. This truncates the playback file from the point where the new recording begins, so the developer must complete the operation entirely from there.

FIGURE 1: *Command File*

```
.FSHOW.
.VIEW.
    .FILE. %Authors file        %
    .FIELD.
        .ADD.
            .YES.
            %Authors file.*     %
            .USERDEF.
                .STRING.
                    "2" .ENTER.
                .ENTER.
                .CONSTANT.
                    "CL" .ENTER.
            .COMPLETE.
            "NEWST" .ENTER.
            .ENTER.
            .LEFTJUST.
        .ESC.
    .ESC.
    .RESTRICT.
        .NEW.
            %State              %
            .EQ.
            .CONSTANT. "CO"
            .ENTER.
        .COMPLETE.
    .ESC.
    .EDIT.
        .MODIFYALL.
            %State              %
            %NEWST              %
            .FSHOW.
            .YES.
            .FSHOW.
    .ESC.
.ESC.
```

The keystroke sequences needed for an operation can be recorded and played back. This sequence of commands replaces all instances of the state "CO" with "CL."

A more flexible editing method is with a utility program that extracts the keystroke sequences from Xtrieve's internal format file and places them in a standard text file in the form of key words that can be edited with a text editor. The utility then converts the text back to internal format. Figure 1 shows a sample command file.

Command-file functions allow a window of descriptive text to be displayed anywhere on the screen at a desired point during playback. Xtrieve displays these windows either for a specified time or until the user presses any key. This time delay can be used to display comments or instructions.

Text for the window displays is stored in a text file, with each block of text preceded and terminated by special codes. Text messages must be in the same sequence as they are called

by the command file. This is a difficult process for the developer—unless these two files are maintained in synchronization, the messages will be displayed out of sequence. Time delays, if specified, are relative to the speed of the microprocessor rather than real-time. This could create portability problems if an application is moved to a faster or slower machine; on a faster machine, for example, messages might not be displayed long enough to read.

Command files in Xtrieve can be made interactive with functions that allow the user to select from a menu or enter a parameter while the file is being played back, as well as display text and create special menus that play back other command files. However, the command files have no provision for any conditional execution, branching, or logic. The Xtrieve tutorial uses a custom menu and command files.

Xtrieve's security mechanism is identical to Btrieve's. The user assigns an eight-character name to the file, which then is required to open the file.

THE REPORT OPTION

For $145 ($345 for the multiuser version), users can generate reports from views defined in Xtrieve using the Report Option. Like Xtrieve, the Report Option is menu driven and is surprisingly versatile, once the user learns the proper techniques. Although the manual and tutorial describe the operation and provide examples, they fall short of giving the user a full understanding of the techniques required.

The first step in creating a report is to define a view that contains the desired fields and the appropriate indexing sequence. The Report Option is loaded into the system by selecting REPORT from the main menu.

A report layout (photo 2) is *form* oriented, with many forms possible per page. In the simplest case, a form and a page coincide; but in many cases a page includes multiple forms, as with multicolumn mailing labels, where each label is considered a separate form. Page and form dimensions are defined separately. If a form is smaller than a page, Xtrieve asks how many forms are to be included (across and down) and offers calculated defaults.

Xtrieve buffers an entire page of output before sending it to the printer or other output device or file. Therefore, Xtrieve can fill a page with forms either from left to right or top to bottom first. This feature, not available with most other packages, lets the Report Option generate a multicolumn

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db/LIB calls look like this:

- CALL GetREC (file%, status%, record#, recdata$)
  → returns into recdata$ the data from record# of the file file%;
  → status% shows successful completion.

Some other db/LIB routines:

- OpenDBF() Creates or opens Datafile
- DefineSTR() Defines data structure
- PutREC() Writes a record to disk
- OpenNDX() Creates or opens Index file
- AddKEY() Puts a key into Index
- GetKEY() Finds a record based on key
- DeleteKEY() Deletes a key from Index

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- Links with BCOM or BRUN modules
- Conforms to the QuickBASIC standard CALLing convention

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report in the format of a telephone directory, where names are in alphabetical order from top to bottom and each subsequent column—or form—picks up where the last one left off.

Pages can have headers and footers consisting of any number of lines. These not only contain constant information such as titles and column headings, but they also can include special functions for printing the page number, date, and time, as well as directives to center a line. In addition, escape sequences can be embedded to control special printer features such as boldface and wide print.

Data fields within the report can be placed at either an absolute position or relative to the last field defined. Absolute positioning, which specifies both the row and column, is especially useful for positioning data in specific boxes on a preprinted form. Relative positioning is best suited for traditional reports because it allows the format to be changed more easily.

Xtrieve provides control breaks by including fields in a *group*, which is controlled by a change in a control field. The control field is printed only once for each group. Groups can contain additional control fields for subgroups. Subtotal headings and summary statistics can be printed for fields when a control break occurs.

During the definition of a report, Xtrieve displays a ruled screen with a mock-up of the report as defined. The layout screen shows headers, footers, and field positions, as well as control breaks. When complete, a report layout is given a file name and description. Once stored, it appears on a menu and can be retrieved for future use. Although the file view is not stored with the report layout, it is needed for subsequent report printing. The user is well advised to record the keystrokes needed to recall both the view and report layout in a command file.

TESTING XTRIEVE

The *PC Tech Journal* sample application for data managers was run using Xtrieve alone, without programming or the direct use of Btrieve utilities. This sample application, which implements part of a magazine's editorial inventory system, is designed to test a data manager's performance and features. It requires the data manager to define three related files, generate an input screen, and perform several different queries, reports, and benchmarks. *PC Tech Journal* runs the benchmarks under identical conditions to assure equal treatment. (For a detailed explanation of the sample application, see "Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46.)

Except for a custom data-entry screen and field validation, no programming was necessary to implement the sample application and benchmarks. Command files were used for convenience, however.

The data-file structures required by the sample application, including permanent indexes, were created with the DEFINE option from Xtrieve's dictionary menu. Once defined, the files were then opened as a view containing all their fields; the translate facility uploaded the data from *PC Tech Journal*'s sequential data files.

The queries were performed simply by defining a view containing the desired information. For example, the sample application's article file contains a list of all articles, their authors, the issue volume and number, fees, along with a number of other fields. In order to determine which articles were booked for a specific issue, a view was created containing each article's title and author. Next, a restrict condition was specified to include only those records pertaining to a specific volume and number. These conditions were

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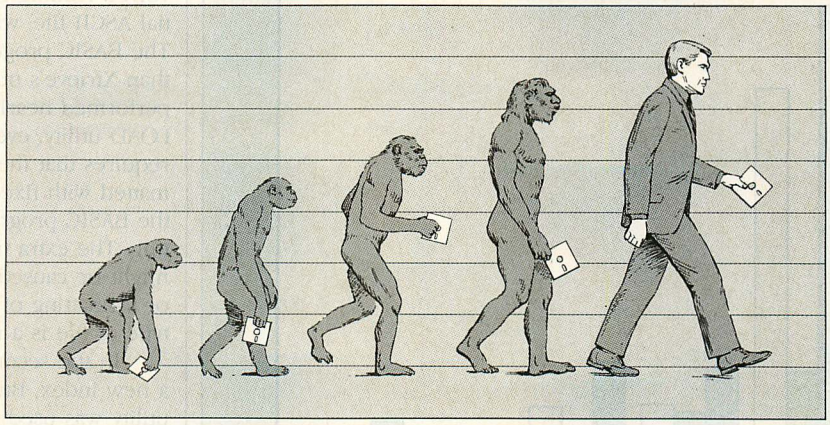
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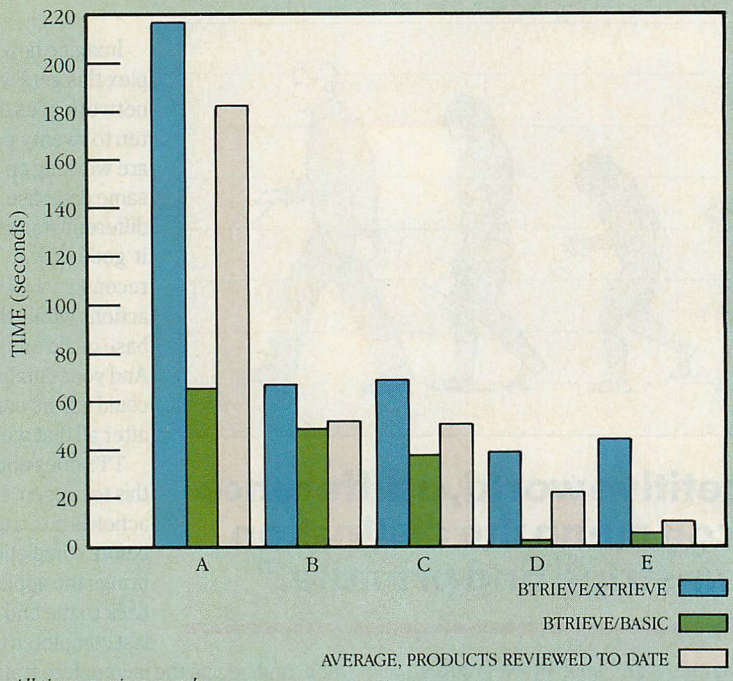
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FIGURE 2: *Benchmark Results*

BENCHMARK TASK	TIME BTRIEVE/XTRIEVE	TIME BTRIEVE/BASIC
A. Add 900 records to an empty data-base table	217 (474)[a]	66 (349)
B. Index table on two fields (7 bytes)	67 (67)	49 (49)
C. Document and tally codes from one column[b]	69 (69)	38 (38)
D. Mass change of one column (28 rows of 900)	39 (48)	1 (3)
E. Extract selected records to create a text file	44 (44)	5 (5)



All times are in seconds.

All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run in an 8MB partition on a CMI 20MB disk under DOS 3.0.

[a]Numbers in parentheses are the results with data integrity, which can exact a price in reduced speed, especially when adding or updating records.
[b]Indexed on state code only (2 bytes) for Btrieve/BASIC.

Btrieve is a peppy performer when run from BASIC without integrity checks. Xtrieve is slower—even more so when integrity checks are in place.

saved to disk for later use. The BROWSE option on the view menu was used to view the bookings for a specific issue.

To determine fees paid in a given issue, the Payment and Bonus fields, plus a user-defined Total field, consisting of the sum of the payment and bonus, were added to the view. The SUMMARY selection from the view menu provided a count of the records and totals of the fees paid.

Reports were generated in the same way as queries, with a view defining the fields and records to be included. The sample application required three reports; two were in column format with breakpoints and subtotals, and the third printed mailing labels for authors. Preparing the reports presented no problem using the Report Option.

COMPARING BENCHMARKS

For comparison, the benchmarks were run using both the Btrieve-Xtrieve package and Btrieve with Microsoft QuickBASIC 3.0. QuickBASIC is a compiled BASIC that is compatible with the standard PC BASIC. However, QuickBASIC provides many enhanced constructs such as multiline functions, IF statements, DO loops, SELECT CASE, and the long-awaited EXIT statement that allows terminating a loop without a GOTO. (For a review of QuickBASIC, see "BASIC Face-off," Justin Crom, September 1987, p. 136.)

As expected, the Btrieve-BASIC benchmark programs were more difficult to write than they would be in a fourth-generation database language such as dBASE III PLUS. They all required more than 100 lines, including normal comments and white space. After the programs were compiled, they were linked with Btrieve's BASIC interface, BASXBTRV.OBJ, which provides communications with the record manager.

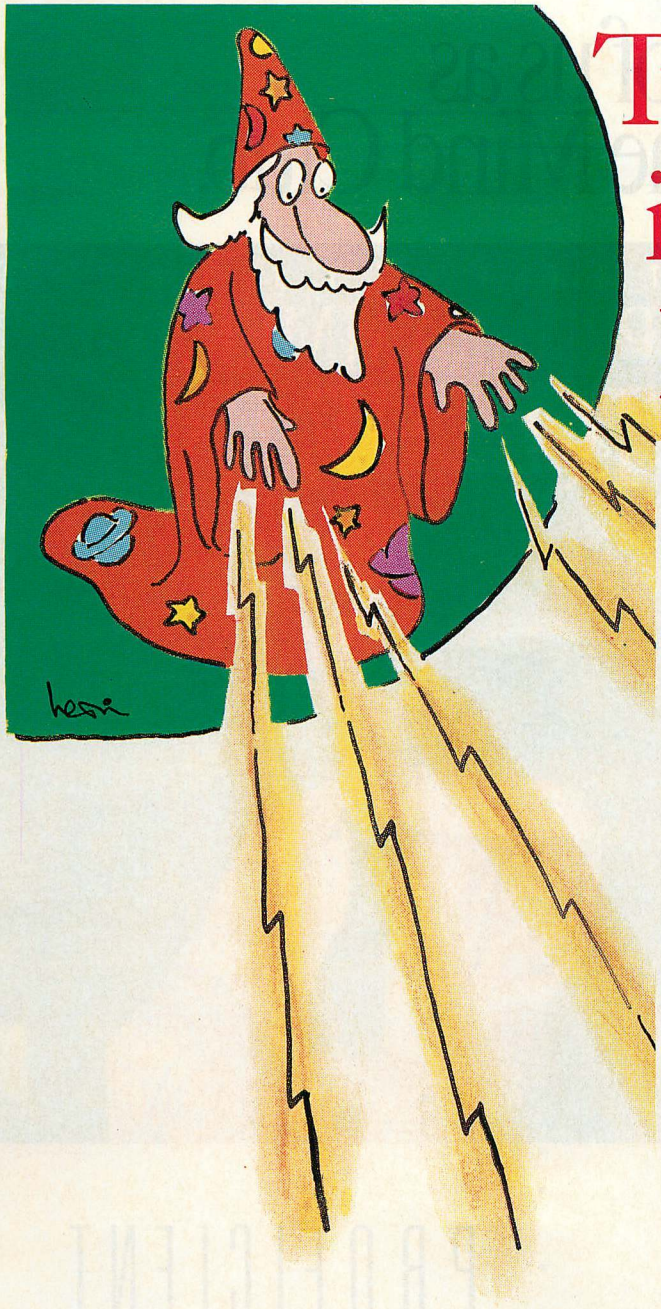
The benchmark program results, shown in figure 2, underscore the contention that a dedicated program can outrun a more general program and that lower-level languages are faster than higher-level languages.

The first benchmark, which involved loading records from a sequential ASCII file, was the most surprising. The BASIC program was much faster than Xtrieve's translate facility, and it performed nearly as well as Btrieve's LOAD utility, even though the utility requires that the input file be preformatted with fixed-length fields and that the BASIC program do its own formatting. The extra time spent by Xtrieve might be caused by inefficient reading or formatting of the sequential file; this type of file is a native BASIC format.

In the second benchmark, creating a new index, Btrieve's BUTIL -INDEX utility was used to create an external index file; no programming was necessary. The times required to create the index were very similar to Xtrieve's times. This is not surprising because both Xtrieve and the BUTIL utility program probably use the same algorithm, if not the same code.

The third benchmark counts the number of occurrences of each state code in the author file. BASIC was faster at this task than Xtrieve's Report Option. Two versions of the BASIC state-counting program were run. The first used the seven-character index (state abbreviation plus zip code) created in the second benchmark as the file index, as suggested by the *PC Tech Journal* benchmark specifications. (The results shown in figure 2 are those from the first version.) The second version, which was considerably faster than the first, used a two-character index on state code only, indicating that Btrieve's performance is highly sensitive to key length. The difference in time is out of proportion to the expected time differential to string-compare five additional characters; it could be due to additional disk activity, because fewer keys can be stored in a "page" of disk information.

Because Btrieve allows a key to be modified, changing all occurrences of the state code "CO" to "CL" was easy in the fourth benchmark. The program repeatedly requested a record with the index "CO" and then changed it to "CL" and updated the record. When an



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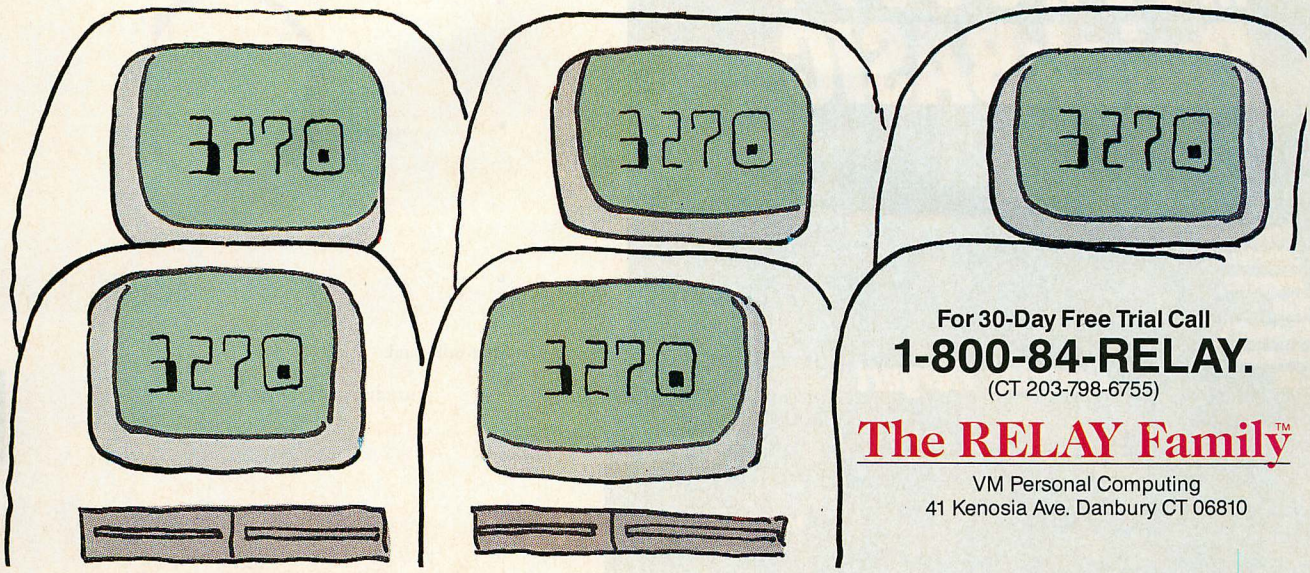
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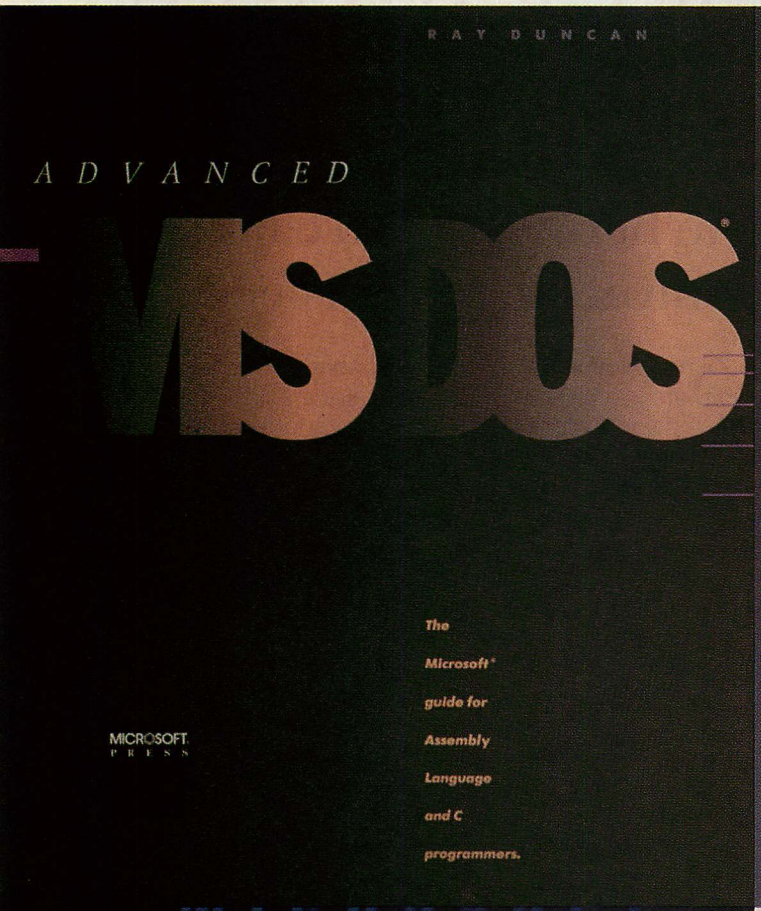
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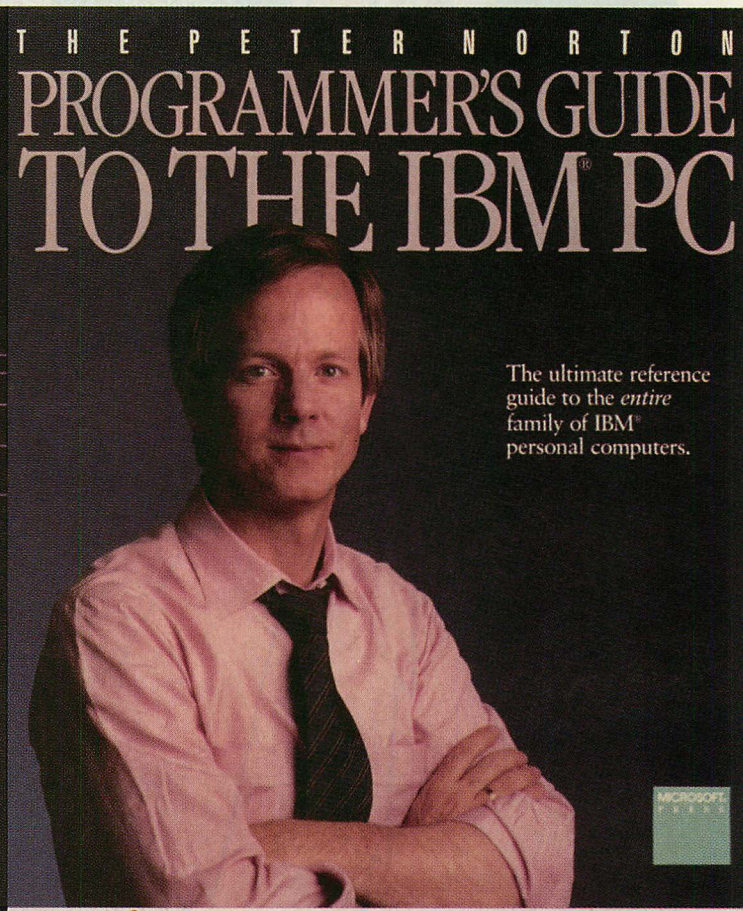
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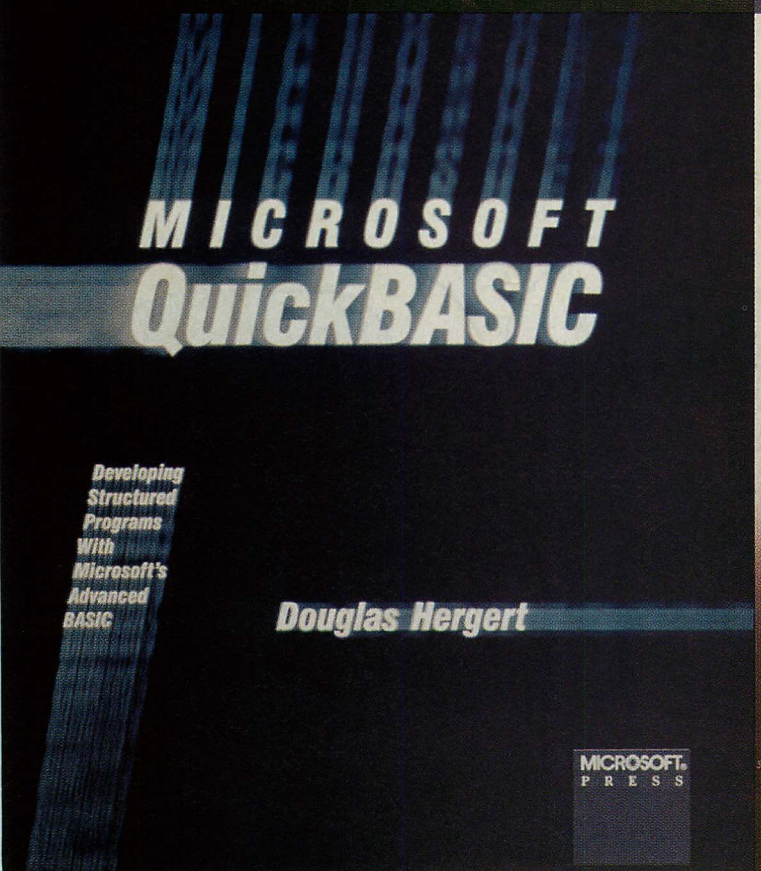
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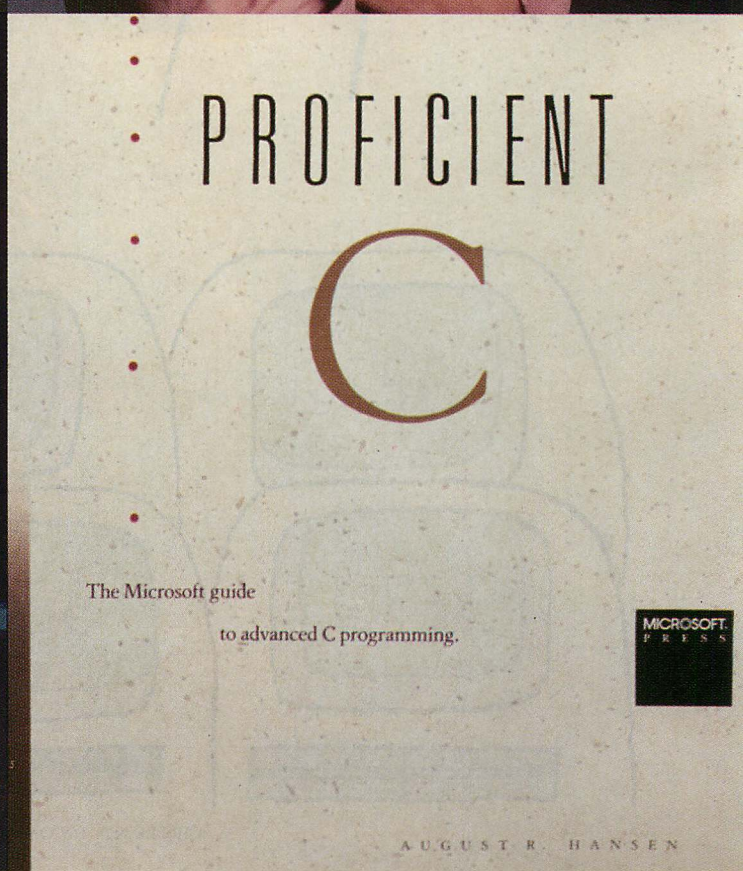
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error indicated no key matching "CO," the program was finished.

The fifth benchmark posed more of a problem. It involved selecting all state codes of "CA" in zip-code order, using the index created in the second benchmark. Because Btrieve does not allow a partial key for access, it could not access the first record with CA as a state code without also knowing its zip code. Thus, the program was written to scan the file in index order until the first CA was found in the state field, then write all subsequent records containing CA to a sequential file, and stop when the first non-CA record was encountered. This technique avoided reading most of the file.

In these last two benchmarks, BASIC's times overwhelmed the Xtrieve times because Xtrieve had to read the entire 900-record file to select the desired records, while the BASIC program took advantage of the file's existing state code index and accessed the records directly. Although this may be unfair as a benchmark comparison, it illustrates the advantages of brain over brawn in algorithm design.

Xtrieve performed below average on the disk-intensive tests. Although performance improved by switching to accelerated access (which disables preimaging and the defensive access techniques), the Btrieve module was still significantly faster using BASIC. The first benchmark, which was the most disk intensive, especially benefitted from the accelerated mode. Creating an ad hoc index resulted in the best relative performance, although data access using such an index is slower than using an index created with the file.

A DIFFERENT CONCEPT

For the developer who chooses to write in an established programming language, Btrieve is an excellent tool for file and record management, including full-keyed access, transaction-oriented processing for concurrency, data security, and automatic crash recovery. Xtrieve is a menu-driven relational query system and report writer that is compatible with Btrieve, but it lacks the tools necessary for an integrated application. The pop-up windows present a fourth-generation image to the user, but the developer sees a cumbersome internal structure that is difficult to maintain.

A typical Btrieve application has a large number of files. The data dictionary has four or five related files, depending on whether security is used. Separate files are used for the keystrokes and messages of the command sequences and for each view and each report. If any of these files are missing or improperly constructed, an application might not work—and the relationships between files is not always obvious, which makes debugging difficult.

Xtrieve is conceptually different from many other database management products in that it is primarily a query and report generation add-on to the Btrieve record manager, which is intended specifically for developers writing in their language of choice. As such, it does not have—or need—the programming features expected in other development systems.

Writing programs that use the Btrieve record manager for file access is generally more difficult than writing programs in a dedicated database language. For each access, the user must set several parameters, test and handle errors, and unpack and interpret fields. While more tedious, this approach provides a flexibility unavailable with most fourth-generation database languages, much in the way that assembly language provides flexibility over higher-level languages at a cost in convenience and development time.

Xtrieve is a flexible query system with a good report writer, but its simplistic record and playback method of implementing command files makes a DOS batch file look like an advanced language. The command files could be used as a shell for a complex application if only they were a little smarter. They can run an external program and return to Xtrieve, but lack any means to test and jump. Without this ability, the command files are not user-friendly enough for the front end of a commercial application. This makes it difficult to integrate Xtrieve with a Btrieve-based application, although this is its logical function. Xtrieve cannot stand alone as a data manager.

The combined package offers an alternative to fourth-generation languages, which can often be restrictive, especially for the developer who needs to perform a significant amount of processing quickly and plans to sell more than one system. However, for an individual or casual user, it is significantly more expensive than the popular fourth-generation database systems, especially when networking options are required. For nonprogrammers, Btrieve is clearly not an option.

Burks A. Smith is manager of Systems/Data Communications at United Telecommunications, Inc., located in Kansas City, Kansas.

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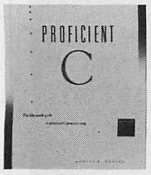
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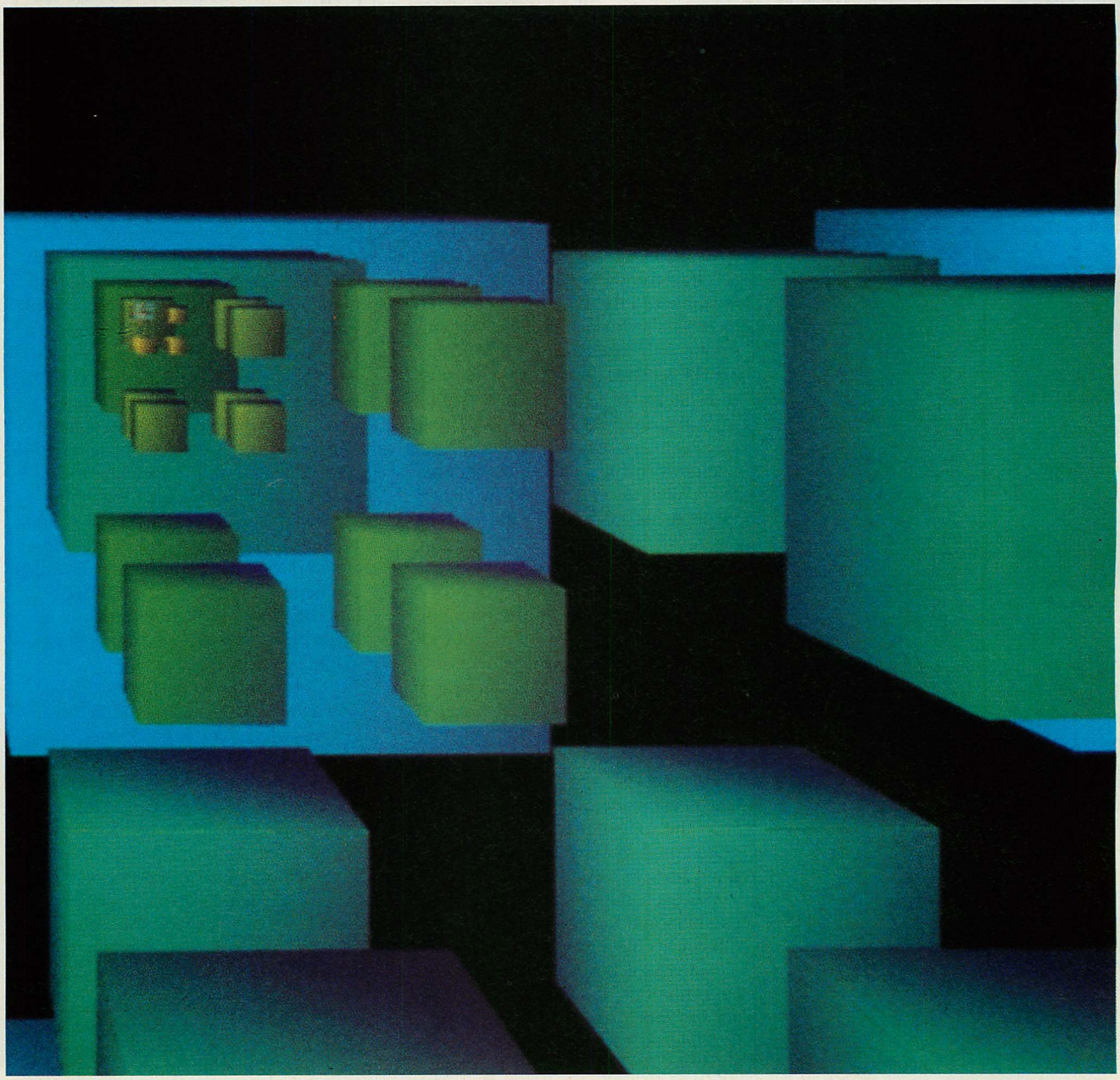
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A Data Manager that Eliminates Programming



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The powerful MAGIC PC data manager takes the programming out of complex application design.

VICTOR E. WRIGHT

Most competitive data management packages require the developer to design the database structure and to write programs that create and maintain the database. Many applications generators claim to eliminate the need for programming but do, in fact, generate code. Although these can save time in writing code, the developer often feels obligated to improve the code.

Aker Corporation's MAGIC PC is a complete, custom, database applications environment for the professional developer that provides tools to build new applications incorporating all the latest database management techniques—the relational database model, windows that allow for the scrolling of data, pop-up menus, and so on. What sets Aker's MAGIC PC apart from most other packages is that this data manager eliminates the need for a procedural programming language.

MAGIC PC is not an applications generator in the usual sense because this package has no code to create, maintain, or tune. Yet, MAGIC PC can be used to develop and execute database applications as complex as those developed under conventional database management systems (DBMS). In addition, Aker maintains that the professional can develop applications faster with MAGIC PC than with any DBMS based on a procedural language—and with no sacrifice of functionality.

How can this database manager duplicate the performance and flexibility of a more conventional system without resorting to procedural programming techniques? It includes a database engine, just as an expert system includes an inference engine. From a set of rules defined by the developer, the database engine infers ways to handle mundane data-management tasks, such as opening and closing files, reading and writing records, sorting files, locating records, and creating indexes.

Although the Aker literature stresses the importance of eliminating programming, it does not gloss over the applications development work that remains to be done. The developer still must perform the systems analysis, design the database structure, and understand the sequence in which various components of the application operate and how they interact.

The minimal hardware needed to develop MAGIC PC applications is an IBM PC/AT, PC/XT, or PC (upgraded with a hard disk and 512KB of RAM). The program is distributed on two diskettes, in keeping with the stated disk requirement of 700KB. Because MAGIC PC is designed for large applications, data storage requirements dictate the practical requirements for disk capacity. Storage requirements are modest for development, because the program files are relatively small—an AT without a hard disk or a Personal System/2 with a 3½-inch diskette drive is a workable development environment. However, for any real-world application, a hard disk is needed to store the data.

MAGIC PC's displays do not use graphics, so virtually any display can be used. The program does, however, make effective use of color when a color display is used. A printer is a practical requirement but not an absolute necessity for development.

DOS 2.0 or later is required, although some DOS-compatible operating systems could prove incompatible. The determining factor is MAGIC PC's use of SoftCraft's Btrieve as a record manager. If Btrieve does not work under a particular operating system, neither will MAGIC PC (for more information, see our review of Btrieve in this issue, "A Data Manager with Language Flexibility," Burks A. Smith, p. 104).

The current version of MAGIC PC runs only on the Novell network. Both single and multiuser versions are included on the standard distribution diskettes, which contain both the MAGIC PC program and two versions of Btrieve. The Btrieve version loaded determines whether the MAGIC PC environment is single or multiuser.

Installation is straightforward. An installation program creates a directory for MAGIC PC, then automatically copies the files from the two distribution diskettes to the hard disk. The DOS COPY command, however, works just as well. The program is not copy-protected. Documentation consists of a tutorial and a reference manual in a single, loose-leaf binder.

OBJECTIVE MEASURES

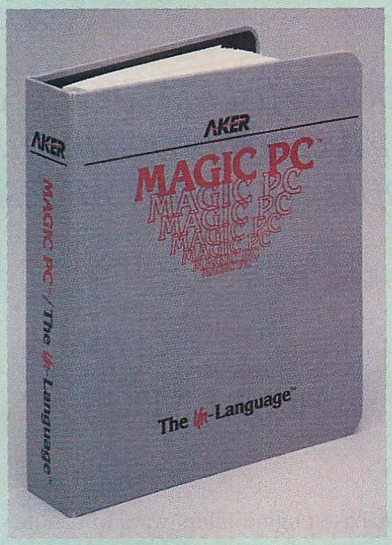
MAGIC PC is a substantial DBMS implementation based on the relational database model. One database can have a maximum of 999 files, each file consisting of fixed-length records of up to 2,048 bytes or fields (whichever comes first) per record. File size is limited by DOS. Keys can be fields, parts of alphanumeric fields, or combinations of fields. The developer can define as many as 24 keys for a single database file, and each key can contain up to 10 segments or fields. Keys can be unique, but they do not have to be.

Files also can link to eliminate data redundancy. Links are *dynamic*—specified in the program (task) definition rather than in the program's Data

MAGIC PC OVERVIEW

MAGIC PC 2.36
Aker Corporation
18007 Skypark Circle Drive
Suite B2
Irvine, CA 92714
714/250-1718
CIRCLE 341 ON READER SERVICE CARD

Product description. A database application-development system, consisting of a design module and a runtime module. Allows the development of complex database applications without the use of a programming language.
IBM PC environment. Requires an IBM PC, XT, AT, or compatible, with 512KB of RAM and a hard disk with 700KB free. Supports DOS 2.0 and later, plus color and monochrome monitors on video adapters that support Monochrome Display Adapter (MDA), Color Graphics Adapter (CGA), and Enhanced Graphics Adapter (EGA) modes.
Other environments. Unisys DOS work-alike environment.
Network support. Standard package includes both single-user and multiuser versions. Documentation for using MAGIC PC on a Novell network is included in the manual.
Copy protection. Not copy-protected. An installation program is provided, but the package can be installed with the DOS COPY command.
Documentation. Loose-leaf manual in IBM-style slipcover. Manual includes tutorial and reference section.
User interface. User interface for both the application developer and the end user relies heavily on function keys, windows, and pop-up menus. Primary difference between developer and



end-user interfaces is the range of functions available.
Help facilities. On-line help is available from virtually any point in the program's operation. Help is context sensitive and is always invoked with the same function key.
File capacities. 2,048 fields per file (record size), 999 data files, and 15 open files. The file size is limited by DOS. Further, the record size is 5 bytes minimum and 2KB maximum. The keys per file are 1 minimum and 24 maximum; the segments per key are 1 minimum and 10 maximum; the key size is 1 byte minimum and 250 bytes maximum.
Field types and capacities. Integer field is 4 digits and uses 2 bytes; long integer, 9 digits and 4 bytes; real, 6 digits and 4 bytes; extended, 14 digits, 8 bytes. Date and time fields are stored numerically. Each uses 4 bytes. Alphanumeric field is 2,048 characters and uses 1 byte per character.
Data entry. Pictures, data types, required fields, assign expressions (default values), display-only fields, and conditional input.
Application development facilities. Design module includes built-in screen editor for screen and report layouts; window-design editor; built-in functions; nested tasks; and virtual fields (local variables).
Security. Developer implemented. New version will add security.
Access to system facilities. User exit from running task to a DOS command level and an automatic return to the suspended task.
Queries, sorting, and reports. On-line sorts by non-key fields, with up to 10 criteria; query mode included. Reports can be columnar, multiline, and indented; labels are multi-up.
Utilities. Include a Convert program to reorganize and pack data files; a program and data structure checker; documentation printing; and Copy utility to copy control files.
Data compatibility. ASCII files in column mode, single delimiter, and double delimiter format can be read.
Distribution. Direct sales, distributors, value-added retailers, and consultants.
Price. $695 list, $199 introductory offer for the design package; $95 for the runtime module; $19.95 for the demonstration package.
Support. 90 days free support. Annual paid support includes hotline, updates, electronic bulletin board, personal consultations, and individual training sessions.

—Victor E. Wright

Dictionary, and ended in the same manner. A linked file is an extension of the original file. It is established using data equivalence in fields or keys of the same length and type.

MAGIC PC allows seven data types: integer, long integer, real, extended (long real), date, time, and alphanumeric. Real and extended types are stored as binary-coded-decimal numbers. Date and time are stored as long integers, so arithmetic operations can be performed on them. Arrays are not supported in the current version.

Data are stored and maintained in binary-tree form by Btrieve. Aker selected Btrieve because of its proven performance and its ability to maintain a database automatically. Nevertheless, it incorporated Btrieve into the product as a module. Calls to Btrieve are made through an interface that allows Btrieve to be replaced by alternative file managers if required.

DESIGNING THE APPLICATION

MAGIC PC's development environment consists largely of tables: menu tables, Data Dictionary tables, and the Program Dictionary's task description tables. To design an application, the developer specifies the details by filling-in the tables. The process closely approximates sketching a database schema on paper. Once the tables are filled in, the system is ready to run. A built-in screen editor is used to define on-screen and printed reports.

The program has no command-line interface. The developer uses single keystrokes to navigate through the tables, which are arranged in a hierarchy. Most of the work required to define an application also is accomplished by single keystrokes.

Function keys are used extensively. MAGIC PC uses them for both general operations and developing applications. The 25th line of the screen displays the function keys active at any given time. Function-key assignments are consistent; except for menus that accept selections by function keys, they have the meanings shown in table 1.

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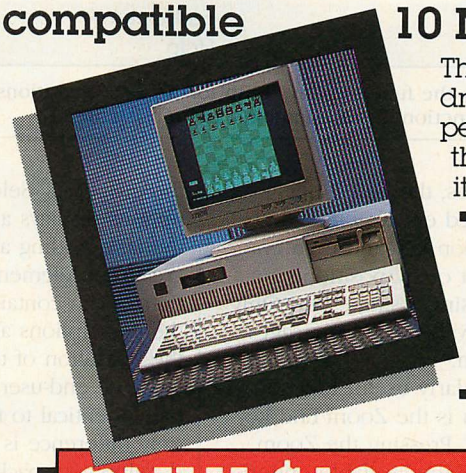
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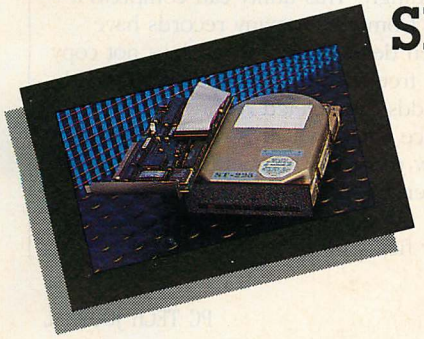
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TABLE 1: *MAGIC PC Function Key Assignments*

FUNCTION KEY	ACTION
F1	Options
F2	Undo
F3	Delete
F4	Add (a line)
F5	Zoom
F6	Expressions
F7	Draw (for screen and form design)
F8	Task
F9	End (return)
F10	Help

MAGIC PC uses the function keys both for general operations and for developing applications. Function-key assignments are consistent.

In most cases, the developer makes the desired entries either by pressing a function key and then entering a single digit or by positioning a cursor and pressing a single key. Only labels, numeric values, and messages must be typed in.

One particularly useful function-key combination is the Zoom/End keystroke sequence. Pressing the Zoom key (F5) displays the available options in a pop-up window containing either a menu or a table. After making the required entries, the developer then presses the End key (F9) to return to the previous point and, in many cases, to paste a value into the field from which the function key was pressed. Once the labels and expressions have been typed in, the developer can also manipulate them by using this point-and-paste method.

Although the development sequence is extremely flexible, the usual sequence is to develop the Data Dictionary and then the Program Dictionary. Menus can be developed at any time; however, they cannot be finalized until these dictionaries contain all the entries to be referenced.

The MAGIC PC developer accesses the design environment by pressing the Options key (F1). At the top level, the Options key allows only one function, maintenance of the system menu. At the subsystems-menu level, the Options key provides access to the utilities and the various phases of application development, including menus, the Data Dictionary, and the Program Dictionary. Selections are made by highlighting or by pressing a function key: F1 for Menu Maintenance, F2 for the Data Dictionary, and F3 for the Program Dictionary (see figure 1).

The bulk of the development process is accomplished by using these three options. Selecting one of these options displays a table appropriate to the task. Adding a line to a table creates an element of the application. Entries can contain descriptions, but the descriptions are not essential for the operation of the application.

The end-user's interface is essentially identical to the developer's—the only difference is in the options. The development package allows an application to be developed, checked, modified, and run in the runtime mode, all without leaving MAGIC PC. The runtime module only executes the application but allows the user to select modes, specify ranges, and locate records.

For the developer, on-line, context-sensitive help screens appear in windows at the touch of a keystroke. The current version of MAGIC PC does not, however, provide a way to use the help facility in an application, although the help screens can be implemented by using virtual fields, subtasks, and windows—the same tools that are used to build the application.

DATA DICTIONARY

The database is defined by placing entries into the Data Dictionary, which is in tabular form. (A schematic view of the Data Dictionary definition is shown in figure 2.) All records are listed in the Data Dictionary's File Table. Each entry in the File Table includes the record's file number, label, number of fields, number of keys, and size in bytes. Files can be appended to the table with no special precautions, but inserting a file into the table requires renaming all the files that follow it, using DOS commands.

MAGIC PC assigns the data-file names. Each name consists of a two-letter, user-specified prefix that designates the system to which the file belongs, plus the string FIL, plus a number between 001 and 999 inclusive, which corresponds to the file's position in the File Table. Throughout the system, data files are referenced by their number, rather than by name.

Other tables in the Data Dictionary are used to define and modify the structure of the data files. These tables are reached by zooming from the fields and keys columns of the File Table. Zooming from the fields column displays a list of each file's fields, including data type and size. Zooming from the keys column displays a list of each key, including its number, label, size, and collating sequence.

Indexes are defined as part of the database definition process after the fields are specified. The entire Data Dictionary, including both data-file and index structures, is stored in the control file. When either a data-entry or an import task is executed, the appropriate database file is created. Indexes are stored in the data files and are updated as records are created.

The database structure can be modified at any time during development. When fields are inserted, all following references are updated automatically, except for formats and attributes in display blocks. The structure also can be modified by running the program after the data files have been created, but the developer must convert the files to the new structure by using a utility called Convert. This utility can be run from the Data Dictionary's File Table immediately after the structure is changed. MAGIC PC remembers the old structure until the File Table is exited using the End key.

The Convert utility can change the record format, reorganize the file in any specified key order, and pack the database files, eliminating the space left by deleted records. Any parameter in the Data Dictionary can be changed, including adding and deleting fields, changing field attributes, defining new keys, and modifying keys by adding or deleting segments.

MAGIC PC updates indexes automatically, but the Convert utility must be used to reorganize the data files accordingly. This utility can compress a file from which many records have been deleted, because it does not copy the free space to the new file. Instead, it adds the deleted records to a free-space chain, which is used for adding new records. The data file grows only when the free-space chain is null.

A data file can be sorted by non-key fields in up to 10 levels, each in

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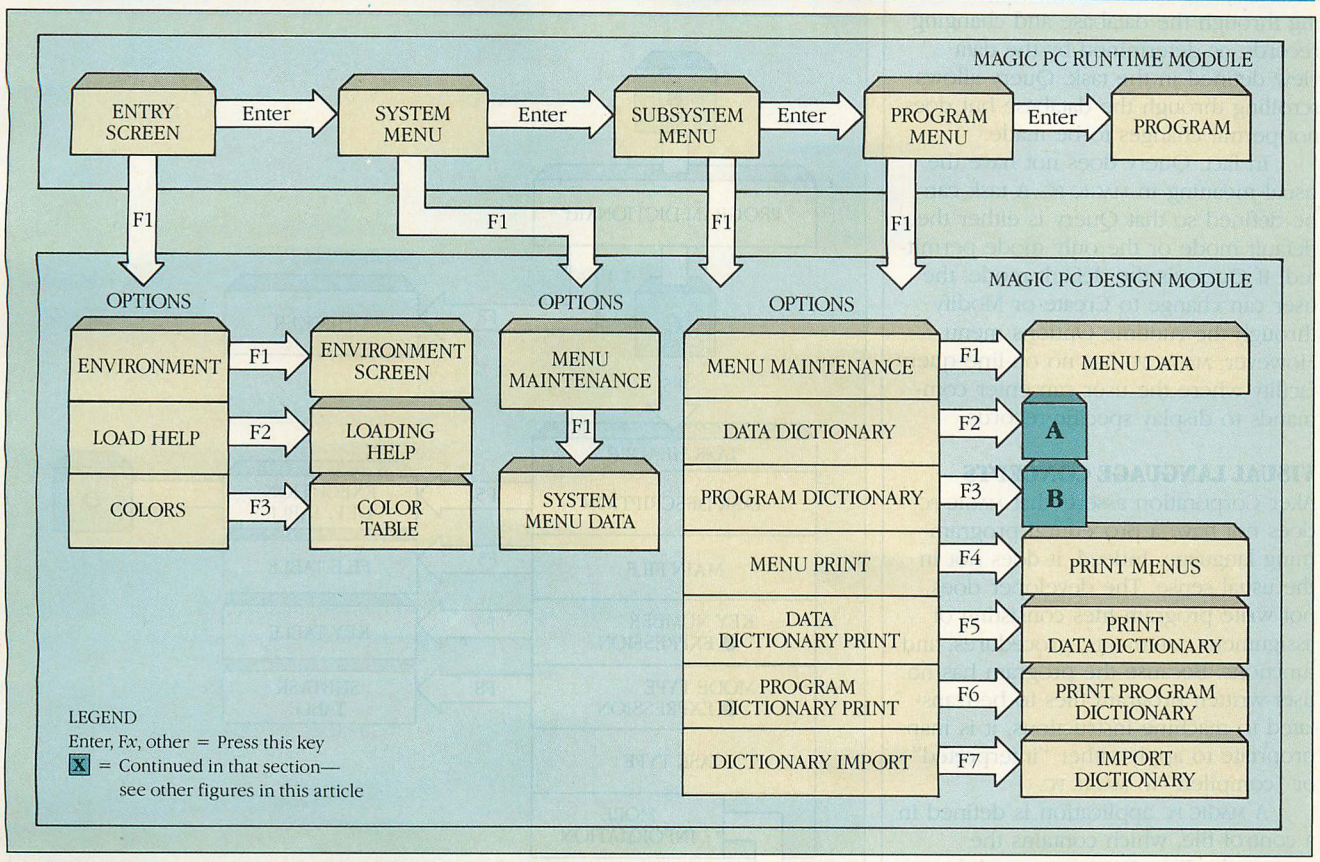
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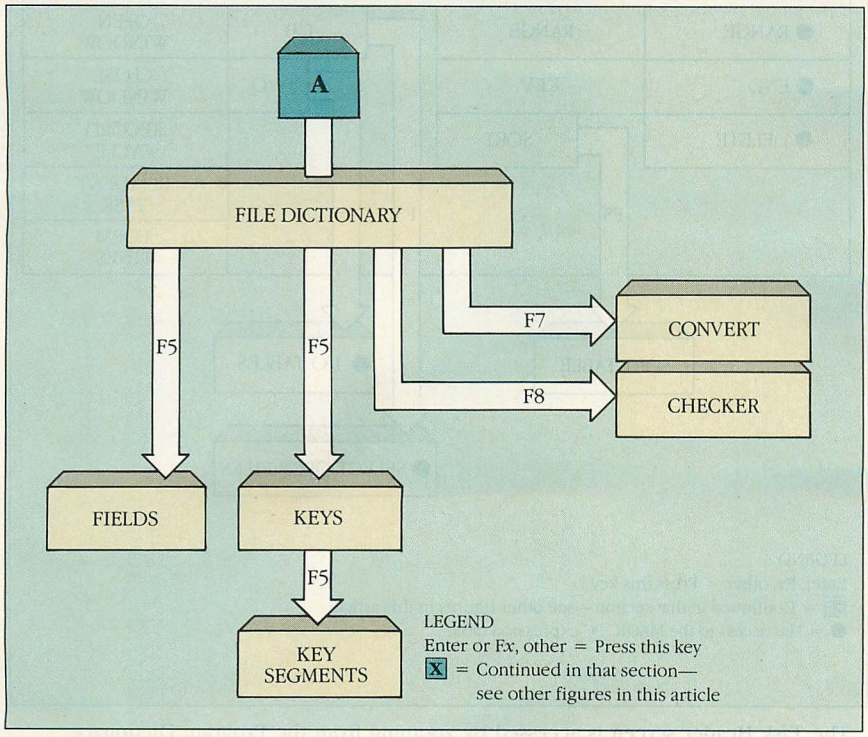
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FIGURE 1: *Schematic of Top Level*



In the full development package, both runtime and development facilities are accessed with single keystrokes. Development and testing can be accomplished without leaving the program.

FIGURE 2: *Data File Definition Schematic*



Top-level screen, Data Dictionary. Field Definition and Key Definition screens are accessed by zooming from the appropriate field in the Data Dictionary.

ascending or descending order. The end user can sort on-line through the Options menu while a program is running. A sort operation overrides the current key until the task is exited or the sort definition is changed.

MAGIC PC'S checker verifies both programs and data files. The checker runs from the File Table in the Data Dictionary or from the Program Table in the Program Dictionary. It verifies the structure of a single file or a single program. If errors are found, the checker stops and displays an error message. Once the error is corrected, rerunning the checker will check the programming from the beginning. The developer must test the entire application to ensure that programs and data files are operating to produce the desired results.

In the runtime mode, the Options menu also provides selections to locate a specific record, to override the range of records that are to participate in the current task, and to change the main key of the current task. Three modes of data-file access—Create, Modify, and Query—can be selected from the runtime Options menu. Create positions

the user at a new record, as determined by the task. Modify allows scrolling through the database and changing records, as determined by the data view defined in the task. Query allows scrolling through the database but does not permit changes to be made.

In fact, Query does not have the usual meaning in MAGIC PC. A task can be defined so that Query is either the default mode or the only mode permitted. If Query is the default mode, the user can change to Create or Modify through the runtime Options menu. However, MAGIC PC has no on-line query facility where the user can enter commands to display specific records.

VISUAL LANGUAGE CONCEPTS

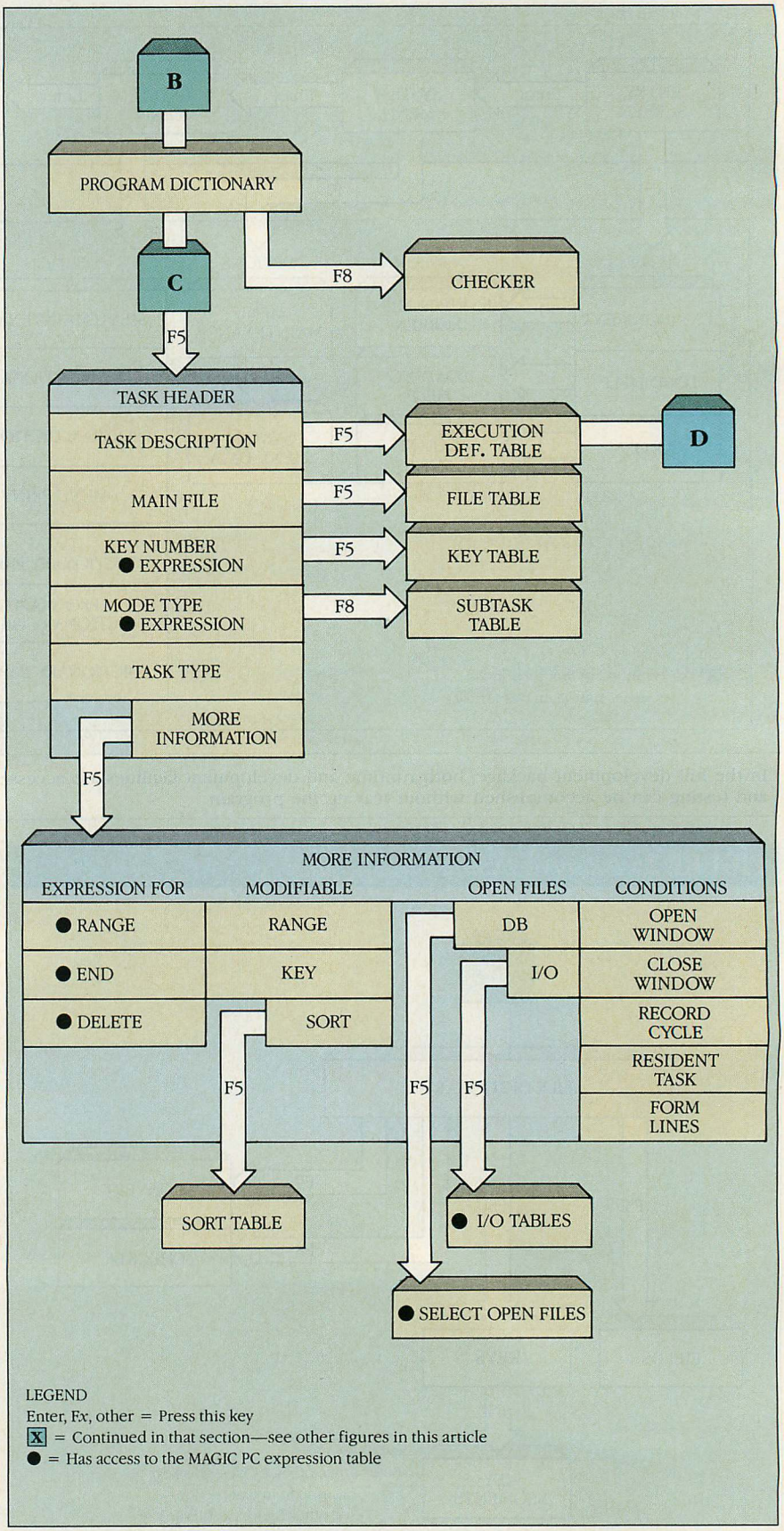
Aker Corporation asserts that MAGIC PC does not have a procedural programming language. Indeed, it does not in the usual sense. The developer does not write program files consisting of assignment statements, procedures, and functions. Because the program has no user-written program files to be translated to machine instructions, it is inappropriate to apply either "interpreted" or "compiled" to MAGIC PC.

A MAGIC PC application is defined in a control file, which contains the menus, the Data Dictionary, and the Program Dictionary. The control file—actually a Btrieve database file—contains the application rules. The MAGIC PC runtime program is a database engine that manipulates data in accordance with these rules. Although MAGIC PC is not an expert system or an artificial intelligence program, it does use similar concepts. Aker has supplied the database engine, and the developer supplies the knowledge base.

MAGIC PC differs from other systems in that nothing can be done with the database structure alone. When the database structure is first defined, it has only the control file. The database files are not created until the application is first run. To create even a minimal application, one that will create a data file and add records to it, a program or a task must be defined.

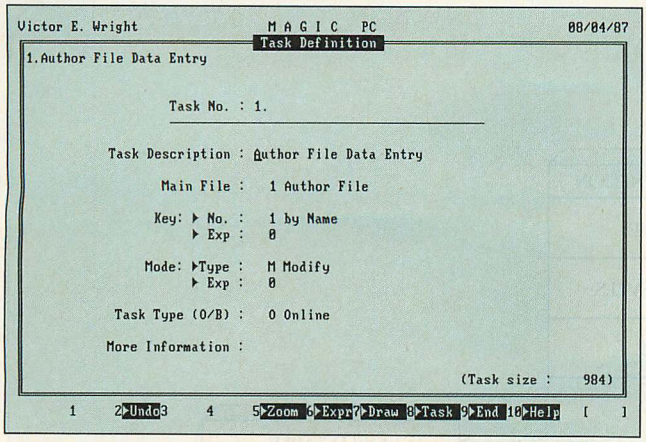
The execution of an application is controlled at two levels. MAGIC PC controls basic operations transparently, such as opening and closing files, reading and writing records, and maintaining indexes; and determines the sequence in which these operations are performed. The developer specifies higher-level operations and determines the sequence of certain aspects of the application, for example, the order in which the cursor parks in the fields.

FIGURE 3: *Task Header Definition Schematic*



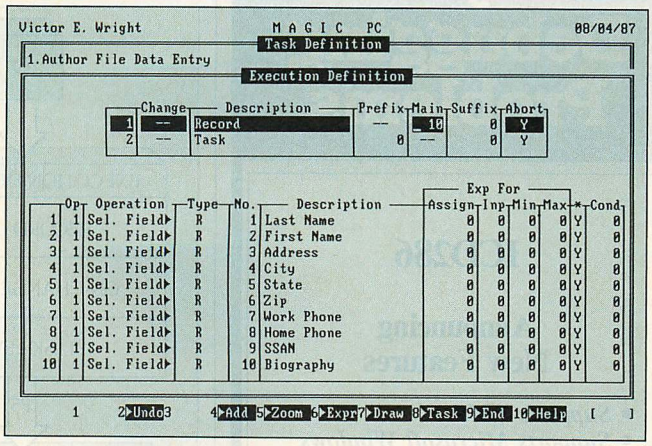
The Task Header screen is accessed by zooming from the Program Dictionary screen. Zooming from the fields of the Task Header screen provides access to the various screens and tables required to define a task and its subtasks.

PHOTO 1: *Task Header Screen*



The first step in defining a task is to specify the task description, the number and description of the main file, the primary key, the operation default mode, and the task type in the Task Header screen.

PHOTO 2: *Task Execution Definition Screen*



Zooming on the Op field reveals the Operations Table; zooming from the Description field reveals the Field Table and from the Exp field allows an expression to be entered for evaluation or condition.

From the developer's point of view, the program portion of an application consists of lists of these high-level operations. These lists are called Execution Tables, and they are contained in the Program Dictionary. (Figure 3 shows a schematic of the Program Dictionary definition.)

The Program Dictionary is reached from the Options menu in the design mode, that is, when the system or subsystem menu is displayed. It lists in tabular form all tasks that have been defined. Each entry contains a number and a program description, which also serve as the label. Adding a line to the table creates a program task, which is empty of operations at this point.

Once the task has been created in the table, its definition can be displayed using the Zoom key. The first screen shown is the Task Definition Table, which displays the Task Header (see photo 1). The header contains the task description, the number and description of the main file to be opened, the primary key, the operation default mode (Create, Modify, Query) selected for the application, and the task type (on-line or batch).

When the task is created for the first time, the Task Definition Table contains the task description that was entered in the Program Dictionary, null entries in the main file and key fields, and defaults for the mode and the task-type fields. The first step in defining a task is the selection of the task's main file. The main file can be any one of the files defined in the Data Dictionary, or file 0—the scratch file—which has an infinite number of records and is never written to disk.

The developer defines the elements of a task by zooming (using F5) to the Execution Definition Table from the Task Description Table (see photo 2). MAGIC PC divides a task definition into four or more levels; each is displayed and defined in an Execution Definition Table. The upper portion of this Table summarizes the execution definition and lists the selections for different levels used for further definition. These levels are executed in sequence when the task is invoked.

They include the *task prefix*, *task suffix*, *record main*, and *record suffix*, and also can contain one or more *on-change* levels. The task-prefix level consists of the operations performed when a task is entered; the task-suffix level, of operations performed when the task is exited. The record-main level includes the tasks performed on individual records while the task is active and on-line; and the record-suffix level, operations performed when changing to a new record. On-change levels instruct MAGIC PC to execute the on-change suffix when it has finished processing a group of similar records, and to execute the on-change prefix before it begins to process the next group. This allows for printing headers and footers for multilevel reports, resetting counters, and so on.

In on-line tasks, the record-main level is used to define the data view and execute operations on the data; in batch tasks, it is used only to define the data view. The record suffix is used to update fields; in batch tasks, it is also used for execution instructions.

Each level of a task is defined by an Execution Definition Table, which also contains fields for specifying the operation and its parameters. Figure 4 shows the 13 operations that can be entered in this table and the related tables that are used to define the parameters of those operations. Again, elements of the task are created by adding lines to the empty tables, followed by entries in the various fields.

A LANGUAGE OR NOT?

Although Aker presents MAGIC PC as a development environment without a procedural programming language, the program has many attributes of a language. Execution Definition Tables specify the sequence in which operations are executed. Looping is inherent in the task/record level structure of a task definition. Operations within a task can be grouped for conditional execution. Subtasks can be defined and called from within a task or another subtask. A task can call itself or another language—MAGIC PC, written in Microsoft Pascal, is recursive. Parameters can be passed to the subtask or another task, and the subtask or task can return results to the calling task. (Subtasks called through Execute Task inherit the fields of the parent task; tasks called through Execute Program do not.) Virtual fields perform the functions of local and global variables. Predefined functions return and convert date and time data; perform mathematical, trigonometric, and Boolean operations; manipulate string data; perform type conversion; return system data; and perform file-pointer tests.

Indeed, it could easily be argued that MAGIC PC does have a programming language and that the primary differ-

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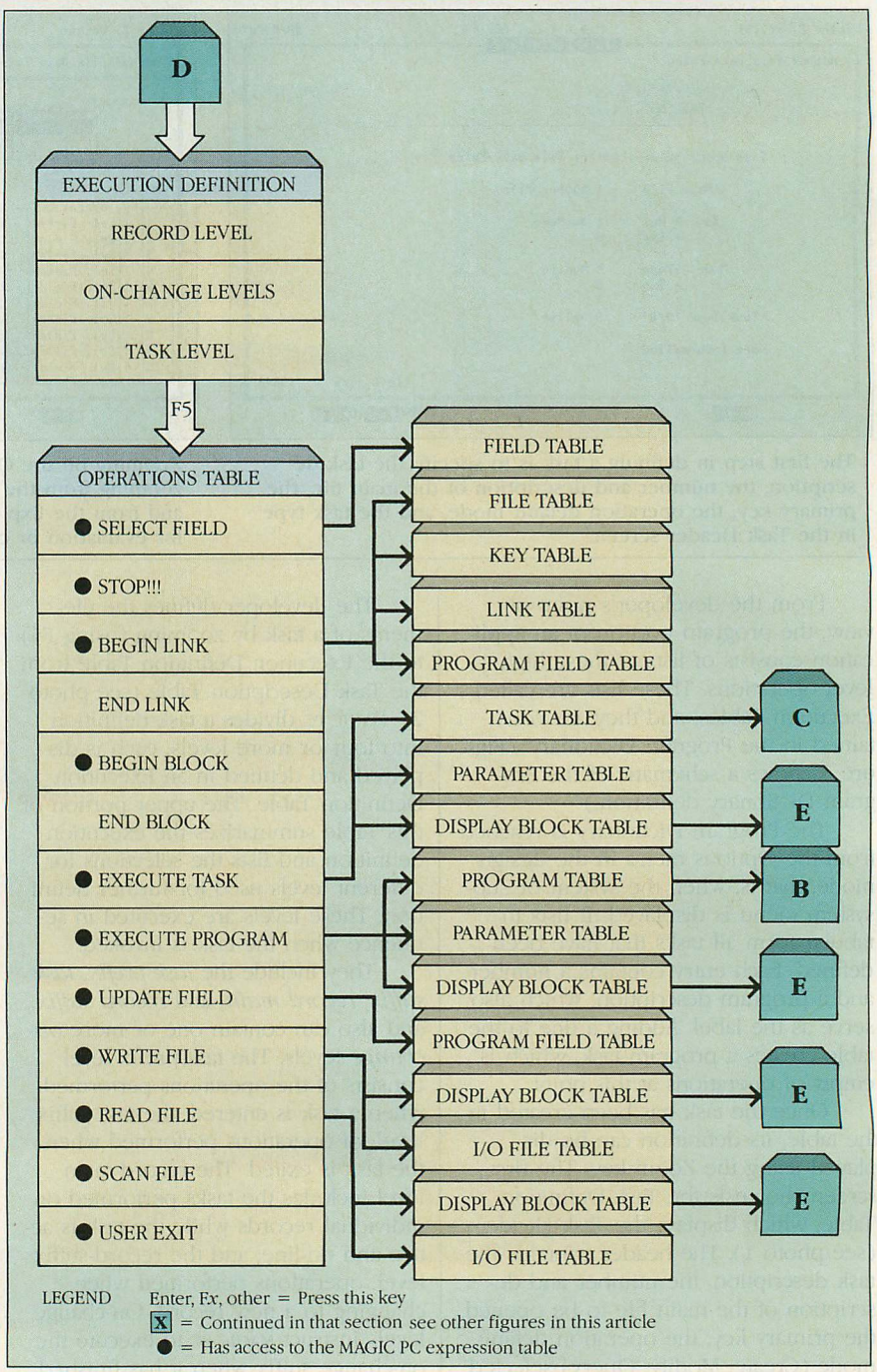
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FIGURE 4: *Task Execution Definition Schematic*



Each level of a task is defined by a Task Execution Definition Table. Thirteen operations can be selected from this table. The parameters for those operations are defined by zooming to other tables.

ence between it and other packages is that MAGIC PC includes an integral editor and requires its use. However, MAGIC PC does not translate entries in the Execution Definition Tables into machine-specific or virtual-machine code by either interpretation or compilation but instead uses them as rules for the database engine. Nevertheless, Aker changed its slogan from the "Un-Language" to the "Visual Database Language" in its most recent advertising (released after this review was written) to convey the idea that MAGIC PC provides an improved development environment without sacrificing the power associated with language-based systems.

MAGIC PC's database engine is the same for both the development and runtime environments. Once an application has been developed, the program replaces the development version

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of the MGMAIN.EXE file with the runtime version. In runtime, the development Options menu is not available and the Execution Definition Tables cannot be displayed or modified.

Because MAGIC PC operates as a database engine rather than as a language translator, many concepts associated with translators are not applicable. For example, it has no code to tune in order to increase execution speed and no interfaces to other languages, although external commands can be executed, command-line parameters can be passed to DOS, and data can be written to and read from external files.

However, some parameters can be adjusted to increase performance speed. One is the method of opening and closing files. MAGIC PC normally opens the files used by a task when the task is invoked and closes them when it exits; child tasks do the same. Instead, files opened by a child task can be added to a parent task's file list so that they are opened when the parent task is invoked. This eliminates the need—and the time—to open and close these files each time that the child task is invoked.

EASY WINDOWS

In the development environment, MAGIC PC makes extensive use of windows, which are easily incorporated into an application. Each task of the application has a main screen and usually has additional screens or windows for the subtasks. At the top window level is the system menu, which displays the system file names. The second level is the subsystem menu, which displays the labels assigned to a group of programs. The third level is the program menu, which displays the labels assigned to the individual programs.

Beginning at the top-level menu, the developer executes functions in runtime by positioning the highlight and pressing the Enter key. The developer then accesses the functions to define the design by pressing the appropriate function keys. He then can zoom-in to define a segment of the application and zoom-out to test it, either by using the built-in checker or simply by running the application.

Screens and windows are defined using the Display Blocks Table, which can be reached from almost any point in the program. As in the case when other parameters are defined, if the developer uses the Zoom key to call this table from the Execution Definition Table, and then uses the End key to exit, the appropriate reference will be placed in the Execution Definition Table. Figure 5 shows the tables and screens that can be reached from the Display Block Table.

Display blocks can be used as screens, windows, record layouts, or report layouts. In any case, the developer is able to define the display blocks by using the screen editor. All printable characters in the extended ASCII character set can be used in the labels, ruling lines, and symbols.

Zooming from the screen editor takes the developer to the Display Field screen, which is used to select and place input/output fields in the display block. On this screen, the developer can select a field for insertion by either pointing and shooting or by specifying its display attributes.

The Display Field screen lists, by file, the fields that have been defined in the Data Dictionary. When a field is selected, the data type, field length, and position in the display block are entered automatically. Other attributes are given default values, but can be edited. When the Display Field screen is exited, the field picture is inserted in the display block. It can be inserted with or without field description, which can be displayed above or to the left of the actual field picture.

An expression can be displayed on the screen by defining a field number 0, instead of using a field listed in the Data Dictionary. The developer enters an expression by zooming to the Expression Table, then selecting an existing expression or creating a new one.

Data validation is specified using the Display Field screen and Execution Definition Table. The screen contains the field-picture definition, which can allow or disallow negative values. A Select Field entry in the Execution Definition Table can assign a default value to a field, enable or disable input to a field, and determine which records are included in the task's domain.

DYNAMIC LINKING

Relations between files—links, in MAGIC PC terminology—are specified in the Execution Definition Table, rather than in the Data Dictionary. A task has one main file and as many linked files as required. Links are not only dynamic, but are also nonprocedural and exist only as long as specified in the Task Execution Definition Table.

Links can be established in the following four modes: *normal*, *read*, *write*, and *always*. These modes allow the user to specify precisely the effect desired on the linked file. A link is es-

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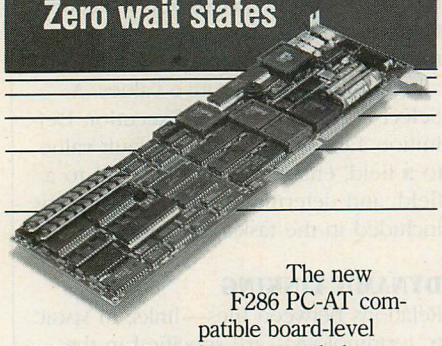
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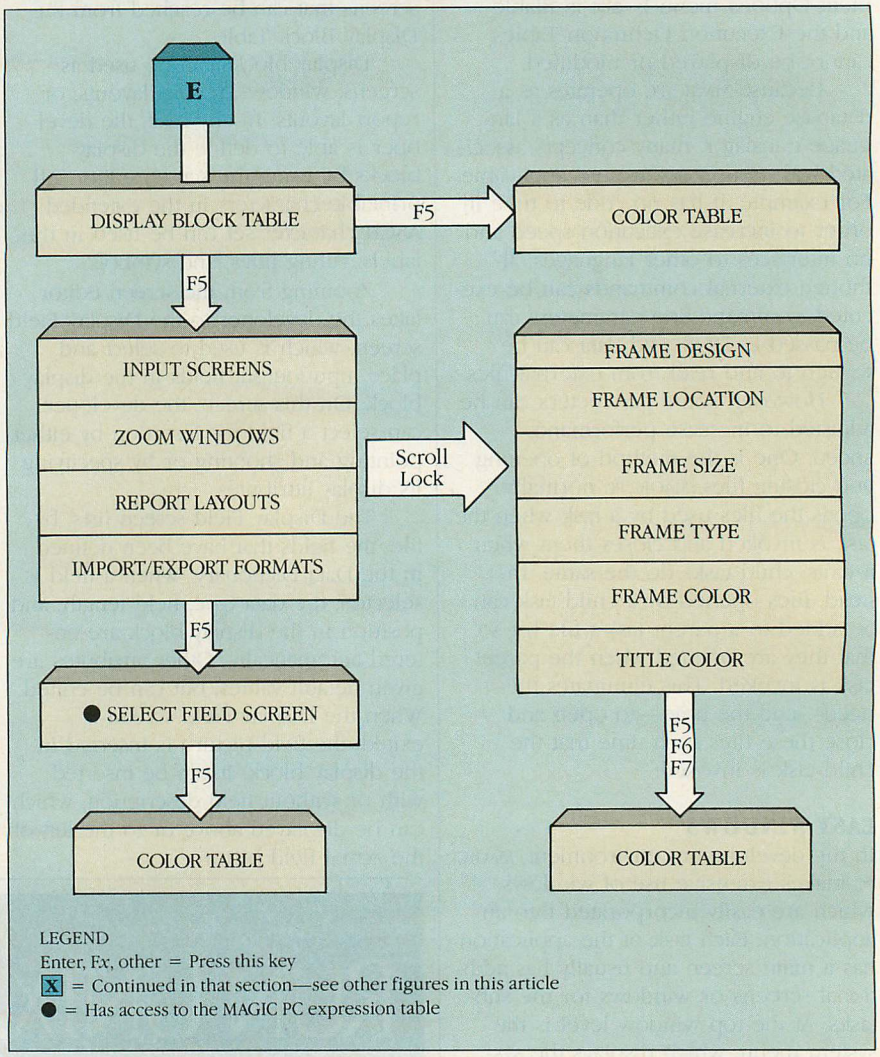


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FIGURE 5: *Display Block Definition Schematic*



The Display Block Table is used to define the visual interface, including input screens, screen displays, reports, zoom windows, and formats for import/export of data. A window editor is accessible with a keystroke.

tablished when a key in the linked file matches a linking expression calculated in the current file. If a link is successful, the first three link modes (normal, read, and write) are equivalent. While a link is in effect, the operations that select real fields do so from the linked file. Thus, many of the files can be updated simultaneously.

If a link fails, the link mode determines the action taken. In normal mode, the process is interrupted, an error message is displayed, and the system waits for different data to reestablish the link. In the read mode, the process continues, but the linked fields are filled with zeroes or blanks. In write mode, the system creates a new record in the linked file, using data established in the assign fields of the Execution Definition Table. In the always mode, the process creates a record in the linked file without attempting to establish a link.

MAGIC PC supports one-to-many, many-to-one, and many-to-many relationships. These relationships are implemented by using the Task Definition as well as the Data File Definition. A unique criterion from a parent file is used to limit the range of records in a child file that participates in a task or a subtask. Thus, a parent task can supply a set of criteria, and a subtask can display and/or process all of the records that meet these criteria. A scrolling window can be defined for the subtask in order to allow the display of several records that meet the criteria.

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Manual size/index	250/No	42/no	469/Yes	380/Yes
Benchmarks in 120K File:				
2000 replacements	1:15 min	34 sec	1:07 min	6 sec
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the screen editor. The user specifies report execution by inserting the write-file operation in a task or subtask, with the appropriate display-block entry and file as parameters.

A printed report typically consists of several display blocks, which are invoked by corresponding write-file operations, in the various levels of a task. Thus, the task prefix prints the report header, the record suffix prints the report body, and the task suffix prints the report footer.

MAGIC PC does not supply default report formats. However, almost any format can be designed. For example, multiline reports, such as invoices with headers and footers, are easily designed on screen.

The key to complex reports is the on-change level of the Level Definition Table, which is listed in the Execution Definition Table. The on-change level allows such activities as printing footers after a group of similar items (for example, all last names beginning with the letter B) and printing of headers before the next group of items.

END-USER CONSIDERATIONS

MAGIC PC is either single-user or multiuser, depending on the batch file that loads Btrieve and the version of Btrieve loaded. Although MAGIC PC supports only the Novell's NetWare, Aker has indicated that MAGIC PC will support other networks when Softcraft adds that support to Btrieve.

Files can be opened in one of the following four modes: accelerated-exclusive file lock, preimage-exclusive file lock, record lock, and share. The mode is specified in the database field of the task header on a file-by-file basis; therefore, different tasks can open files in different modes.

When the preimage-exclusive file lock is specified, MAGIC PC maintains a preimage file for the automatic recovery of the data file in the event that a crash occurs while the file is being updated. The accelerated mode does not provide automatic recovery, but it has a faster response and requires less disk storage space.

Because MAGIC PC is intended primarily for application development, it does not provide some ad hoc facilities found in other systems. Without a command language, it provides no way to instruct the system to open files, close files, browse, edit records, and append records in a purely ad hoc manner.

To exercise the ad hoc facilities that MAGIC PC does provide, a task must be both defined and running. In other words, the application must be developed before the ad hoc facilities become available. It is not possible to define a database and manipulate it on an interactive basis without also defining at least one task, which must at least define the data view.

An ad hoc query facility can be made available to the end user by designing a task so that it displays multiple records in line form. The developer must define first a main task that accepts the various search criteria and then a subtask that displays the records that meet these criteria.

The Options menu in the runtime mode then allows the end user to change the mode to Modify, Create, or Query and to perform the operations Locate, Range, Key, and Sort. Locate, for instance, displays the main screen or the active subtask's window with blank fields. Any field or combination of fields can be filled-in with values. Ending the Locate operation with the End key displays the first matching record. Range allows the user to specify a range for one or more fields. Ending the Range operation displays one or more matching records. Using the directional keys displays additional matching records.

The documentation consists of a single standard-size, loose-leaf binder comprising a tutorial and a reference section. The introduction strongly encourages the new developer to work through the tutorial before attempting to develop applications. This is because the tutorial introduces the concepts that distinguish MAGIC PC from other development environments.

The tutorial is a good one; it is accurate and introduces virtually every topic covered in the reference section. It consists of a step-by-step process for the development of a fairly complex application, complete with zoom windows and multiline screens and reports. On-line, context-sensitive help screens in the design environment closely parallel the corresponding sections of the reference manual.

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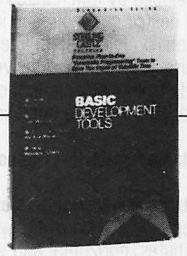
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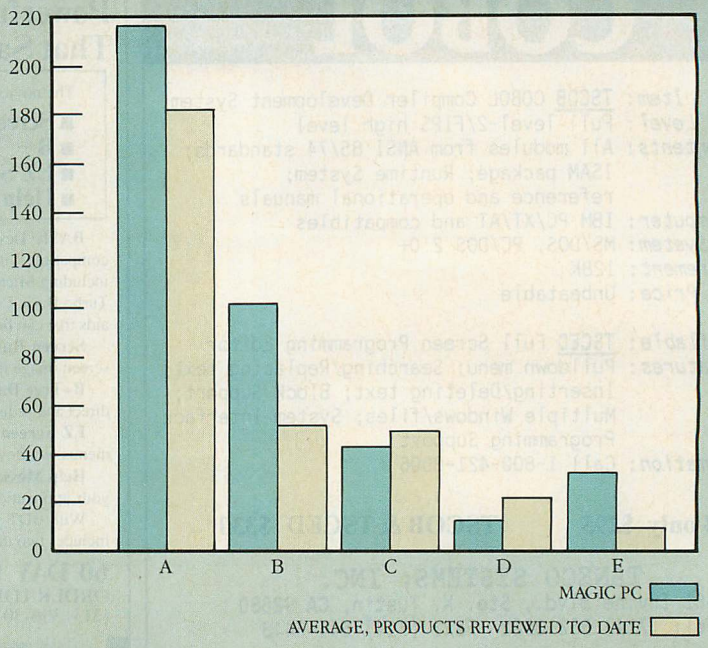
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FIGURE 6: *Benchmark Results*

BENCHMARK TASK	TIME
A. Add 900 records to an empty database table	217
B. Index table on two fields (7 bytes)	101
C. Document and tally codes from one column	43
D. Mass change of one column (28 rows of 900)	13
E. Extract selected records to create a text file	33



All times are in seconds.

All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run on an 8MB partition on a CMI 20MB disk under DOS 3.0

MAGIC PC completed two of the timed benchmarks faster than average. Importing, reindexing, and reporting all authors with a CA state code took longer.

files, the associated indexes, and programs to generate reports and perform benchmark timing tasks.

Defining the database structure was straightforward, even for the developer new to MAGIC PC. It provided a fast, efficient interface and required little in the way of learning new concepts. Defining the three database files and indexes according to the template took only a few minutes.

The database also was implemented without substantial difficulty. However, one field specified as logical in the template was approximated as a numeric field in MAGIC PC, because MAGIC PC does not provide a logical-data type. Another field, specified as a 200-character note field, and preferably a variable-length text field, caused two difficulties; that is, the MAGIC PC data management package does not provide variable-length records and cannot read and write strings longer than 255 characters in import/export operations.

For the author system, three tasks were needed, one for each data file. Each task required a data view that included all fields of the record structure, plus a main screen listing these fields. Defining these basic tasks was accomplished quickly.

To execute the tasks, a menu structure had to be created that provided entries to the system, subsystem, and program tables in order to access the tasks. Just as data files are accessible only through tasks, tasks are accessible only through menus.

In order to import the benchmark database, the following three additional tasks were required: The data view for each task had to be made identical to the data view for the corresponding data-entry task, a main screen had to be defined, and a read file had to be placed in the record suffix with an additional display block to define the record layout. Definition of the author-system reports was a simple matter.

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Mailing labels took less than 10 minutes, and the columnar reports took less than 30 minutes each. Indeed, the reports that were requested by the author system in no way exhausted MAGIC PC's report capabilities.

MAGIC PC performed two of the *PC Tech Journal* timed benchmarks faster than average (see figure 6). However, importing the author file, reindexing, and extracting all authors with a state equal to CA took longer than the average times reported to date.

One limitation appeared during the fifth benchmark, which involves exporting the report file. The write-file operation in MAGIC PC writes only in columnar format. MAGIC PC can produce output in delimited format but requires considerable string handling. The long time needed to reindex the author file occurs because the Convert utility must read the records into the existing file and then write them to a new file, using the new structure.

IS IT MAGIC?

Not really, but MAGIC PC does offer a different approach to applications development, as Aker claims. In fact, Aker does not make the claims that it easily could, given the power of this program. Aker's new slogan "Visual Database Language" appears to be a more appropriate description of the program than its previous one, the "Un-Language." MAGIC PC does have a language, admittedly an unconventional one, and it provides a powerful means for using that language.

The MAGIC PC package not only provides a powerful development environment, but it also precludes the use of other tools in the development process. Because the developer writes no program code, a programming editor is not a requirement. Because the window facility is built-in, a windows package is not needed. In addition, given that the screen editor handles the form design for the screen displays and the printed reports, a forms-design package is not a requirement.

The following two key questions remain to be answered: First, can MAGIC PC be used to develop applications that are equal in complexity to those that are possible in other systems? Second, can that development be accomplished in less time?

From the above discussion, it is apparent that MAGIC PC is equal to the task of developing complex applications. The file sizes, record sizes, number of indexes per file and segments per key, number of data files per database, and other capacity parameters are comparable with those of competitive, but more conventional systems.

The thought that a complex application can be developed by using only 13 operations—while other systems offer scores of key words—may be grounds for some initial doubt. However, MAGIC PC performs many operations automatically that must be specifically coded in other systems. In addition, MAGIC PC accomplishes a great deal with parameters that have to be coded in other systems. The 13 MAGIC PC operations are indeed the equivalent of the scores of key words that are provided in other systems.

With regard to speed, the MAGIC PC developers—or magicians, as they call themselves—report that they can develop applications in a fraction of the time that is required with other systems. One of these magicians, in fact, completely rewrote applications in 10 percent of the time that was required to code the originals.

MAGIC PC does provide this potential. The author system was developed in only a few hours. The database and the basic data-entry programs for the benchmark application were created in less than an hour.

The real issue for most prospective "magicians" is a matter of attitude. MAGIC PC requires the developer to think in unconventional terms. Those who persist in thinking of an application in the terms of a conventional programming language will very likely experience difficulty. Those who can adapt to a new mode of thinking will have little difficulty.

Specifically, the user of MAGIC PC must think in terms of specifications rather than procedures, concentrating on what the application should accomplish rather than on how it will accomplish it. This approach therefore precludes absolute control over the details. Of course, a magician prefers to think of this loss of control as not having to worry about the details.

One example of this is the opening and closing of files. Most DBMS manuals remind the user/developer to follow certain rules. Aker took a different approach—if these operations must be performed so religiously, then put them in the program, not in the manual. However, MAGIC PC does offer control over the manner in which files are opened and closed for applications in which the defaults are not suitable.

Another example is the sequence of execution. MAGIC PC certainly operates in a sequential manner, but the



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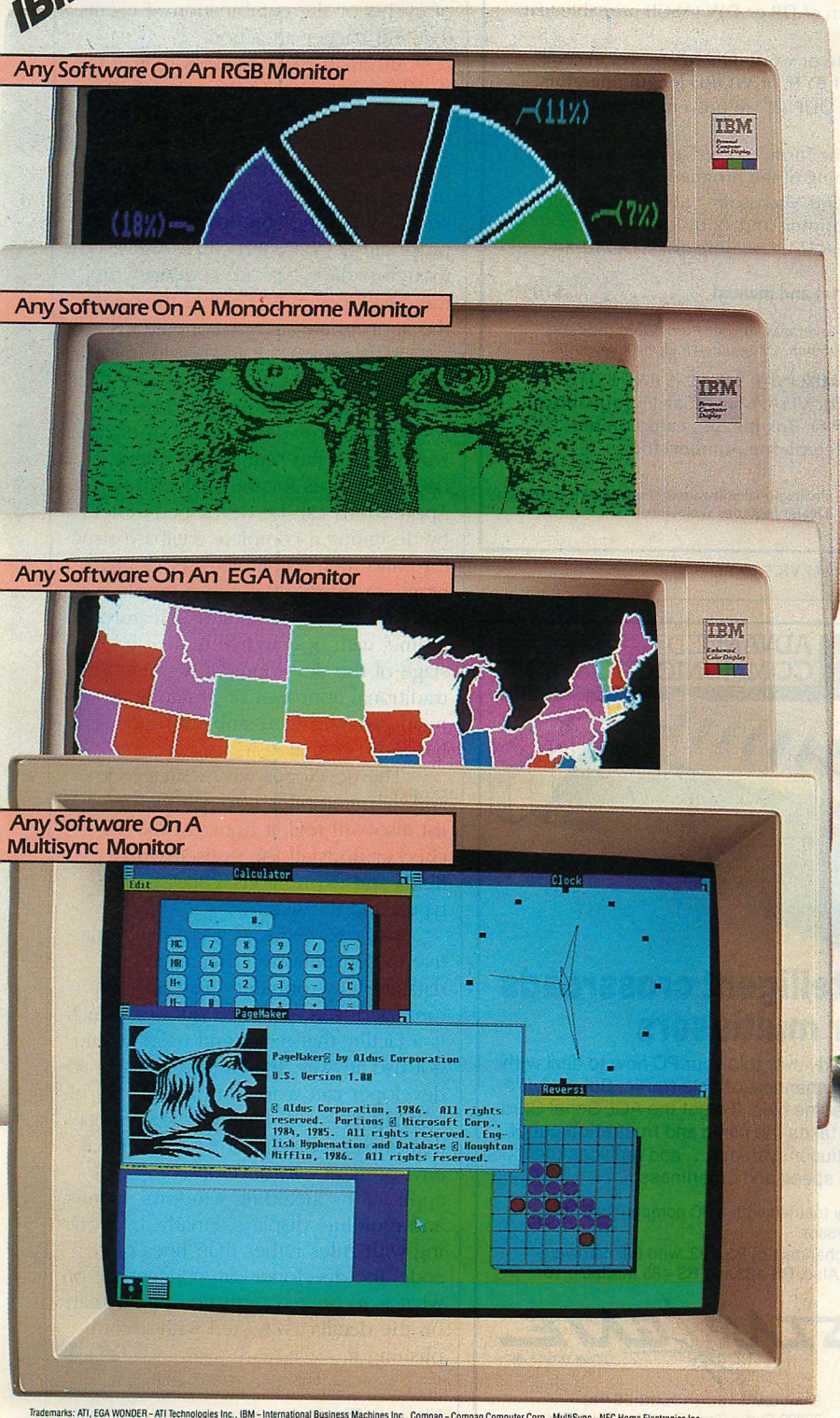
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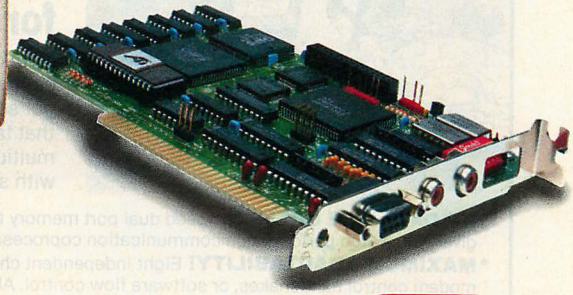
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developer need not be so concerned about the sequence of execution as in other systems. With a strictly procedural programming language, the developer must exercise complete control over the execution sequence. With MAGIC PC, the system determines the sequence of many operations. In many instances, however, the developer has the option of specifying the sequence of events or the combination of events that will trigger an action.

Although MAGIC PC does relieve the developer of the need to oversee many routine tasks, it does not simplify the tasks of systems analysis and actual database design. The developer must understand the requirements of the end user and be able to design an appropriate database structure. And even though MAGIC PC has no code to write, the developer must be able to specify the appropriate MAGIC PC operations.

With MAGIC PC, it is also not necessary to hit upon the exact solution the first time through a project. The MAGIC PC package provides as ideal an environment for the "cut-and-try" developer as it does for the analytical type. Applications can be developed either by designing a complete database structure and then a complete set of programs or by starting with a simple system and then extending it, a feature at a time, with operational tests at each stage of the development process. The traditional approach of designing a main program with stub subroutines has a direct analog in MAGIC PC.

The developer who writes code and then compiles it to see the error list also will feel at home. MAGIC PC's checker finds all the unused virtual fields and expressions, check data types, and the like.

MAGIC PC provides a viable alternative to conventional language-based database environments. The only feature sacrificed is ad hoc queries, which is a facility that many end users would not use anyway. In return, the MAGIC PC developer can work with a small set of operations—with far fewer keystrokes than those required in a conventional environment—to develop complex applications including windows, menus, and multiline displays. Finally, by working with rules rather than lines of code, the developer can concentrate on what is to be accomplished rather than on the details associated with accomplishing it.

Victor E. Wright is manager of process engineering at Luckett & Farley, a firm located in Louisville, Kentucky.



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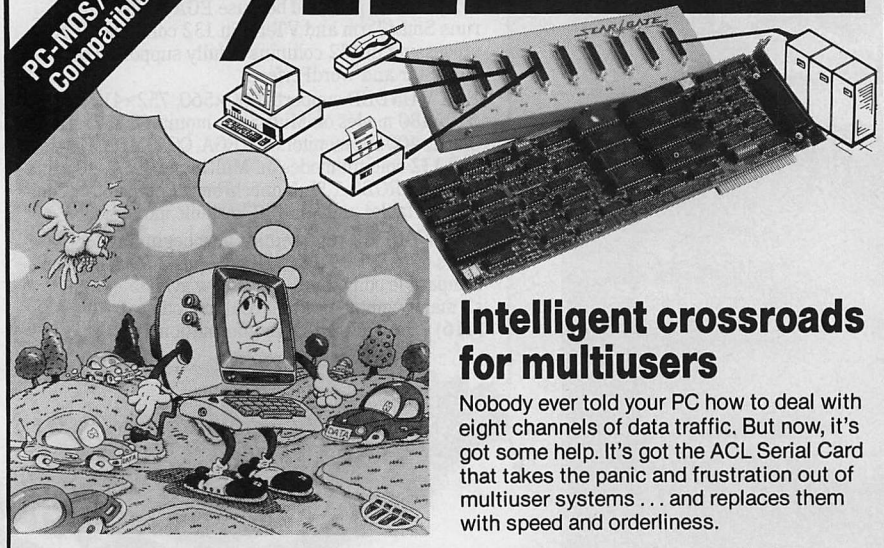
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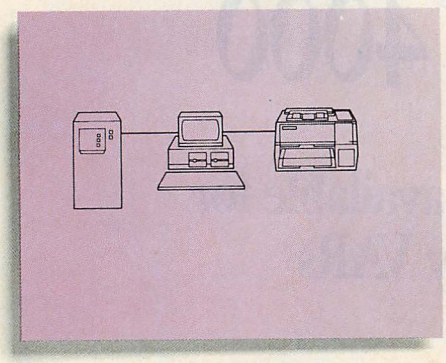
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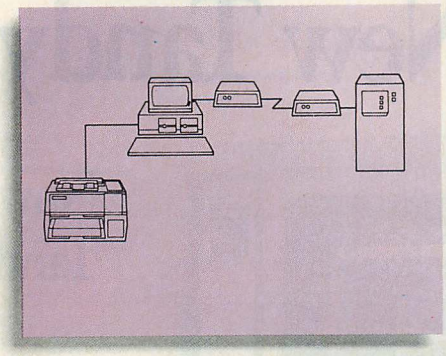
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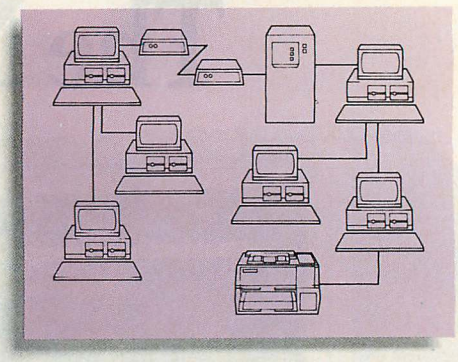
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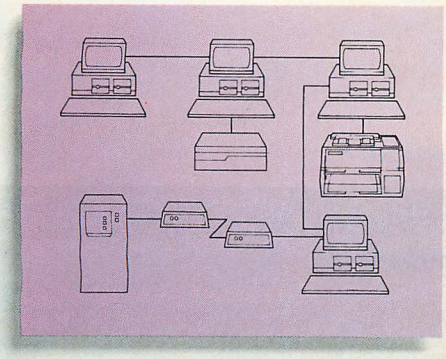


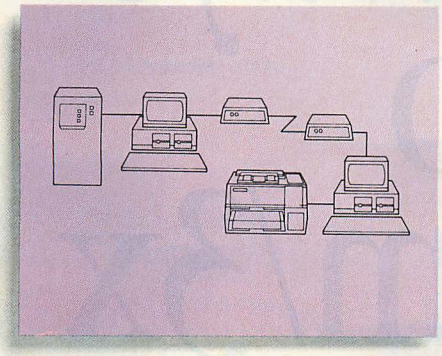
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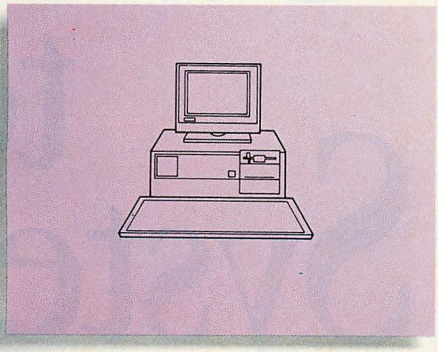
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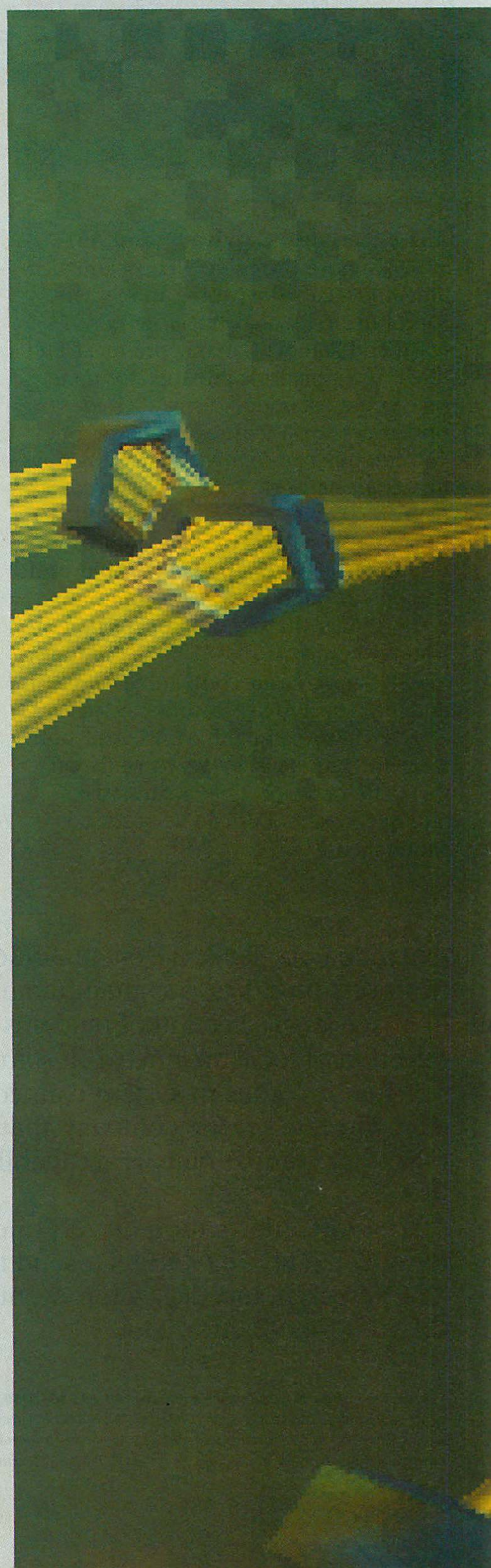
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CIRCLE NO. 248 ON READER SERVICE CARD

AST RESEARCH INC.

Gateways to System/3x

GERRY KAPLAN



In the past two years, the method of communicating with a host IBM System/34, 36, or 38 has changed dramatically. IBM alone has advanced the 5251 concept through a chain of improvements that have led to the introduction of numerous terminal options. Hardware and software products from Asher Technologies, AST Research, and IDEAssociates provide the systems planner with new access paths from LANs to larger IBM machines.

In the early days of the System/34, the system engineer had a choice of installing either a 5251 Model 11 (a local 5251 workstation) or a 5251 Model 12 (a remote unit). Several options were available for these basic units, such as cable-through, which is usually standard now, or dual display, in which two operators can use one unit containing two displays back-to-back and two keyboards.

Around the time the System/36 was announced, several new display stations also were introduced: the 5291-1, a monochrome replacement for the workhorse 5251; the 5292-1, a huge color monitor that appropriated precious desk space; and the 5294, a remote controller that replaced the 5251-12. The 5294 acts as a remote workstation controller, offering more flexibility than the traditional 5251-12.

The method of attaching a PC to the System/36 was then in its crudest form with IBM's first version of the 5251 emulation card. Not much later, the 5291-1 monochrome monitor was discontinued, replaced by the 5291-2 and the 3180; and the 5292 color monitor was replaced by the 3179-2, which had better resolution and a much smaller footprint.

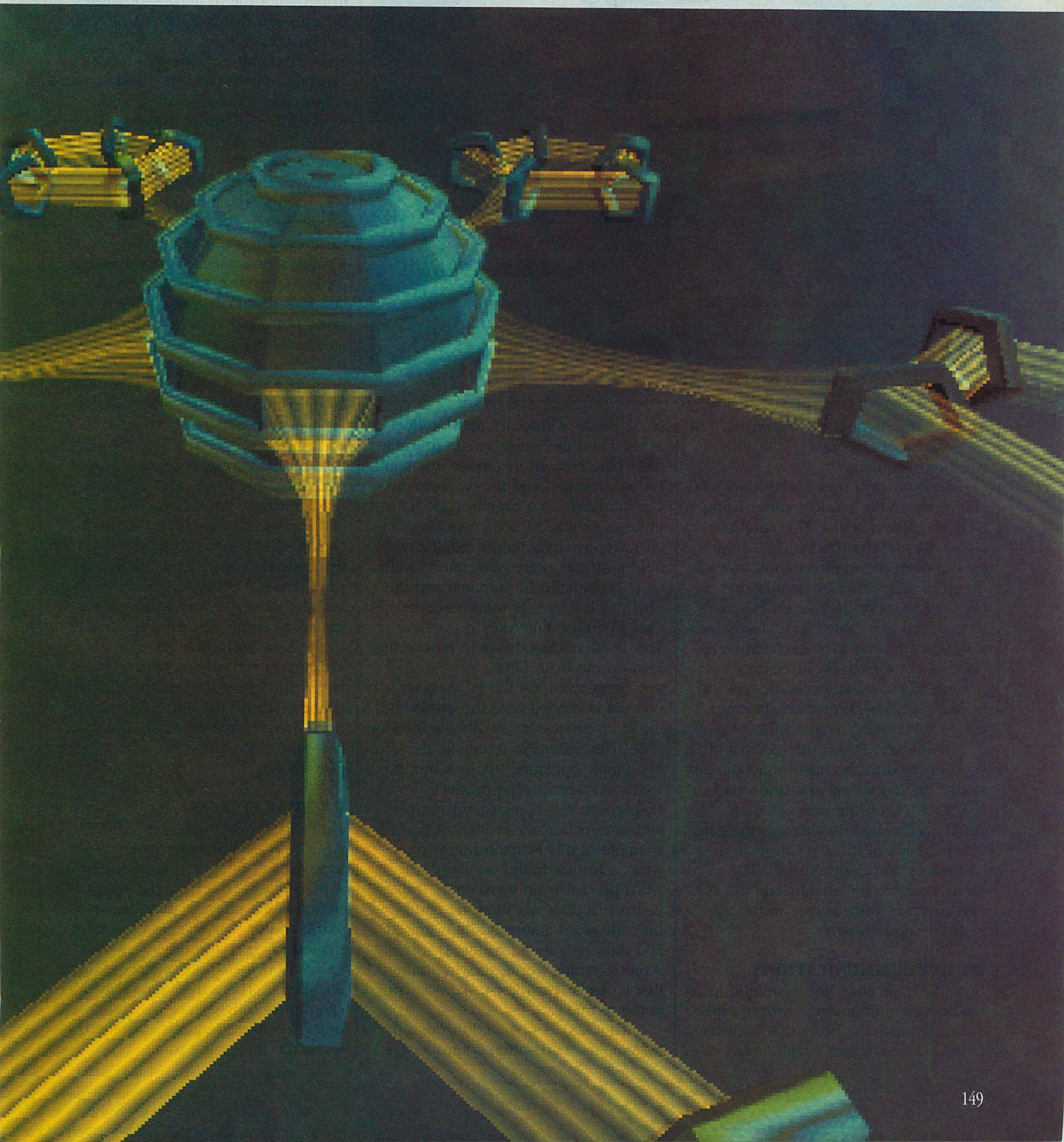
As 5251 emulation became more popular, a variety of boards became available from several vendors (see "The 5251 Connection," Gerry Kaplan, July 1986, p. 131).

In the larger office environment, 5251 emulation has led to the local area network (LAN), in which PCs are replacing (or substituting for) central data processing facilities such as mainframes or minicomputers. However, linking many PCs together does not always solve the requirements of a large data processing system. Frequently, a data processing facility will keep corporate databases on minicomputers and use a LAN to connect all the PCs to interchange mail and other information. This arrangement becomes even more complicated when the PC user requires information from the minicomputer, as well.

Several possible solutions exist for this problem. First, each user could have both a terminal dedicated to the minicomputer for access to corporate databases, and a PC connected to the LAN for all interoffice communications.

COMPUTER GRAPHIC • DOV JACOBSON

A gateway is one cost-effective way to expand host access in a multiuser environment. One of three current 5251 gateway products stands out from the rest.





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This solution is not only expensive, but the least advantageous for a healthy work environment.

Second, each user could have a PC connected to the minicomputer using a 5251 emulation board. This solution also has some drawbacks: cables must be run from the minicomputer to each group of PCs with 5251 emulation boards (no more than seven PCs can be attached per cable); a 5251 emulation board (about $700 each) must be purchased for each PC to be connected; and workstation addresses and ports (if available) must be allocated for each PC acting as a terminal.

Third, one PC on the LAN could be connected to the host minicomputer using a 5251-gateway emulation package. Each PC on the network then could access the host through the gateway PC. Each of these solutions has advantages and disadvantages. The funds available for establishing the connectivity play a major role in the ultimate solution chosen.

UNIQUE COMMUNICATIONS

IBM's 5251 product line is unique in the way it communicates with the host. At first glance, it appears that each terminal is operating in a half-duplex *block mode*, with characters locally echoed and the entire screen transmitted to the host. In this mode, the application programs and the workstations communicate on a page-by-page transmission, instead of field-by-field or character-by-character. All editing and field justification are performed locally by a semi-intelligent terminal and the final product then is transmitted to the CPU when the Enter key is pressed. This is often a good way to reduce the load on the main CPU.

By contrast, on the PC each key pressed is echoed onto the display by the main processor, usually the 8088 or 8086. The System/36 terminals also are not simply operating in block mode. IBM's word-processing product, DisplayWrite/36, scans each keystroke and takes action accordingly. A good example of this is automatic word wrap, a feature found on every real word processor; in word wrap, if the next word does not fit at the end of a line, the word automatically is erased and moved to the next line. DisplayWrite/36 wraps words, too, indicating that it "feels" each keystroke occurring at the terminal.

The 5251 is operated through the System/36's workstation controller (or through the control storage processor on the smaller units). On the larger System/36 machines, the first workstation controller in the system has the capacity to control as many as 32 attached terminals. Each additional workstation controller can control up to 40 additional terminals.

It is the workstation controller that actually echoes each typed character onto the display. When invalid keys are pressed, or an error occurs at the workstation, the workstation controller—not the terminal—originates the message that is displayed on the terminal. Essentially, the 5251 terminals are very dumb, providing only basic capabilities such as clear display, move cursor, and scroll display. It is the workstation controller that brings magic to the vast array of functions that appear to be consistent on all 52xx and 31xx terminals.

Each workstation-controller port on the System/36 can accommodate up to seven devices, in any combination of terminals or printers. For example, one cable to the host computer might contain four terminals and a printer. At any given time, four operators using the terminals might be entering data into the system and the printer might be printing a report. Each keystroke from each terminal must be processed by the workstation controller and echoed back to the proper terminal. Therefore, for each keystroke, a message is sent over the cable to the host computer (each message has an address of the originating terminal), and then sent back to the terminal to be displayed. At the same time, messages containing print data are being sent to the printer, and the messages containing printer status are being sent from the printer to the host. Incredibly enough, no degradation of response is apparent at any terminal, despite the amount of activity taking place on the line. Communications between the terminals and the host take place at the rate of 1 Megabit per second.

GATEWAY EFFECTS

On PC networks, one or more PCs (usually PC/ATs or faster machines) act as servers to other PCs on the network. A PC requests data from the server PC by sending a message over the network, and the server either grants or denies access to the requested data.

Various networks operate at different speeds. The activity on a network can dramatically reduce the response time. The more requests over the network, the longer the wait.

The 5251 gateways complicate the PC network considerably. A 5251 gateway is typically a dedicated PC (an AT or faster for better performance) that is attached to a PC network and a System/3x workstation controller. Some gateways allow the gateway PC to be used as a PC also. However, most manufacturers recommend against this usage, because each key pressed on the 5251 terminal is not echoed locally, but must be echoed by the System/3x workstation controller in the host.

With a 5251 LAN gateway, the following sequence of events occurs for each action. The user presses a key on a slave PC running 5251 emulation. The keystroke is sent over the PC network to the gateway PC, which sends it to the host workstation controller. The host workstation controller, in turn, sends the necessary control characters back to the gateway PC, which determines the correct PC to receive the data and sends a message over the PC network. The slave PC receives the message from the gateway and takes the appropriate action on the display.

Several factors contribute to the performance of this routine. Each PC on the network running 5251 emulation will be making requests over the network. If one of the PCs is connected to a printer and is configured for host-printer emulation, network activity increases during printing. Any printing that takes place on the network server increases activity even more.

Network requests by other PCs increase response time on the PCs running 5251 emulation. In particular, file transfers among PCs on the network may cause poor response time. Word processing on the host can cause an extreme amount of network activity. Displaywrite/36 degrades host performance substantially, not to mention what occurs on an attached network.

Response-time degradation also might occur depending on how the gateway software uses the network. Some network operations require that all communication occur through the server PC, which then distributes the requests to the appropriate slave PC. Other networks allow a PC to send messages directly to other attached PCs.

GATEWAYS

Three different local gateway boards and their software packages were reviewed for this article. Two of the boards, the Asher MiniLink and the AST 5251 Plus, use the networking method described; the other, IDEAcomm 5251 from IDEAssociates, uses a completely different method of PC intercommunication. Networking details, ease of installation and operation, features, and the optional software packages were reviewed for each board. (See table 1 for a comparison.)

Several methods were used to test transmissions from the System/36 to the network. IBM's Programmer and Operator Productivity Aid (POP) was used as a visual check to determine how well each emulation could display heavily formatted screens. When a list of library members is requested from POP, a full screen displays each member's name, plus an input field for making selections.

On a dedicated 52xx terminal, displaying the entire screen takes no more than a second. Emulation boards, however, take various times to display this same screen. Only the IDEAssociates board displayed the screens at nearly the same speed as a dedicated terminal. The other boards equalled the speed only when used as a dedicated terminal, not when running in the network.

All three products were tested using the Novell Advanced NetWare 2.0A and IBM Token-Ring Network hardware. The AST 5251 Plus and the Asher MiniLink boards were run on a network that used an 8-Mhz AT as a 512KB network server, a PC/XT as a 640KB gateway, and another XT as a 640KB slave. The IDEAcomm 5251 was tested with a slightly different configuration, consisting of an 8-Mhz AT as a 512KB gateway, two 640KB XTs as slaves, and an IDEA MiniMax serial card having three serial ports.

Asher Technologies. The MiniLink gateway is shipped in a package with the MiniLink Emulation User Guide, the 5.25-inch gateway diskette, an 8-inch MiniLink XFER36 file-transfer diskette, a twin-axial jumper cable and T-connector, the MiniLink emulation board, seven keyboard templates, and seven user-reference cards. The MiniLink gateway requires PC-DOS 2.0 or later (or MS-DOS 2.1 or later), and it is written to operate on a PC, XT, AT, or compatible machines.

The workstation emulation operates in machines with as little as 128KB of memory. The MiniLink gateway itself also requires 128KB RAM or more, depending upon whether a dedicated or nondedicated server station is used. The amount of memory required by a nondedicated server station depends upon the type of programs that will be



CIRCLE NO. 234 ON READER SERVICE CARD

run on that machine in addition to the server program.

The hardware is designed around the Motorola M68000 chip. Emulation supports seven concurrent sessions, each of which can be displayed in a window at the same time. Windows can be moved and changed in size. The current active window is changed by key combinations (Alt-1, Alt-2, and so on). Cut-and-paste between windows also is supported, allowing for documents to be modified with data from another session. The PC session is accessible by a hot key. Supported terminals include the IBM 5251-11, 5291, and 5292-1. Any of the seven sessions can support host-addressable printer emulation. The printers supported are the IBM 5219, 5224, 5225, and 5256.

Although not tested, according to the documentation, the MiniLink file transfer operates concurrently with the emulation sessions. File transfer can be initiated, then switched into the background where it continues to operate even though the user is working in a different window. The file-transfer software allows for data conversion and imposes no limit on the size of the file that can be transferred.

Other features include user-definable macro keys that allow for a sequence of keystrokes to be defined and then executed by pressing a single key. Emulation allows for either PC- or 5251-style keyboard mapping, and column separators are simulated on the PC's display. Key click also can be switched on or off. Seven sessions can be distributed onto any NETBIOS-compatible network. The gateway server can be dedicated, with only the server program running on the PC, or nondedicated, with the server program sharing the PC with other programs. Any user can have up to seven sessions per MiniLink board, and multiple gateway boards can be installed on the same network.

As with the AST board, discussed below, Asher recommends that gateway machine operate as a dedicated server. Emulation was tested on an IBM XT in both dedicated and nondedicated mode with an AT acting as the network server. Only three sessions were assigned to the gateway rather than the seven maximum.

The MiniLink board was very easy to install; memory address, I/O address, and termination are set on the board itself and not accessible from the outside of the machine. The board was expected to be functional without any changes to the switches. The default

TABLE 1: *Features Comparison*

	ASHER	AST	IDEASSOCIATES
PRODUCT	MiniLink	5251/11 Plus	IDEAcomm
PRICE	$695	$995	$895
CONFIGURABILITY			
Key click	●	○	●
Cursor type	○	●	●
5251 keyboard	●	●	●
PC-5251 keyboard	●	●	●
Enhanced PC keyboard	○	●	●
Customizable keyboard	○	●	○
Alternate addresses	—[a]	○	●
Foreign-language keyboard	○	●	●
Custom printer support	●	●	●
PRINTER/TERMINAL SUPPORT			
Printers emulated			
5224	●	●	●
5225	●	●	●
5256	●	●	●
5219	●	●	●
Terminals emulated			
5251	●	●	●
5291	●	●	●
5292	●	●	●
3180	○	○	●
Graphics support	○	○	●[b]
Windows	●	○	●
Resizable	●	○	●
Movable	●	○	○
BUNDLED SOFTWARE			
Software security	○	●	○
On-line help	●	●	●
Automatic sign-on	○	●	○
Screen snapshot	○	●	○
File-transfer software	●	●	○
Low-level program interface	●	●	●
COMPATIBILITY			
IBM FSU	○	●	●
IBM transfer facility	○	○	●
PC support	●	●	●
MISCELLANEOUS			
Full 5251 display options	●	●	●
DMA	○	●	○
Dual-ported RAM	●	○	●
Communications method	Net	Net	RS-232
EVALUATIONS			
Installation	Easy	Moderate	Easy
Configurability	Easy	Moderate	Easy
Speed of screen refresh	Fast	Fast	Very fast
Keyboard response	Slow[c]	Slow[c]	Normal
SPECIFICATIONS			
Memory required (KB)[d]			
Server PC	128	235	128
User PC	128	190	128
Number of local sessions	7	7	4

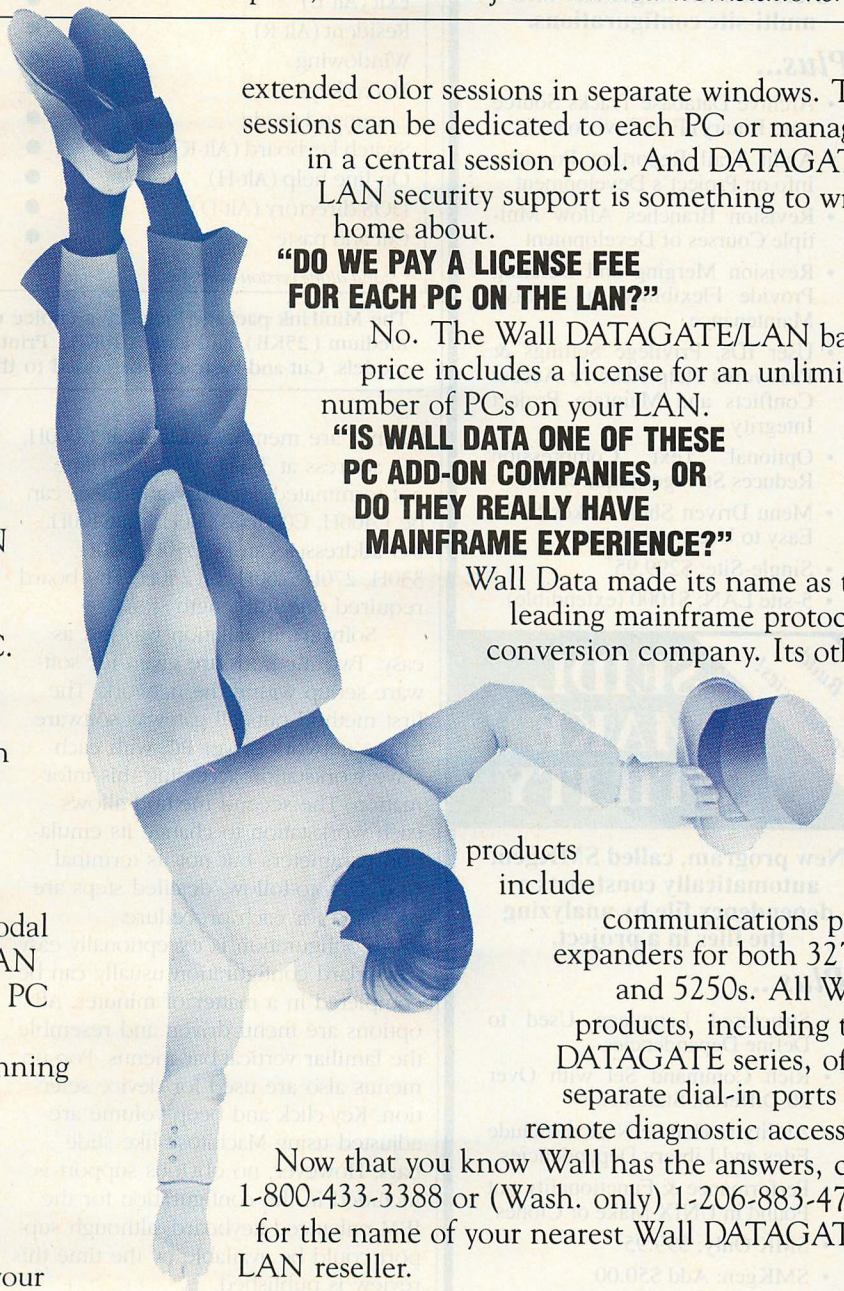
● = Yes ○ = No

[a] *User is prompted for alternate address, not automatically designed.*
[b] *Support for saving and restoring PC graphics upon hot key to System/3x session.*
[c] *Might be improved using an 80286-based gateway machine.*
[d] *On Asher and AST boards, additional memory is required for the network overhead.*

All three packages offer a variety of features. In the IDEAssociates configuration, the slave PCs are connected directly to the gateway rather than through a LAN.

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TABLE 2: *MiniLink Memory Model Features*

	LARGE	MEDIUM	SMALL
Seven active LUs	●	●	●
Select LU (Alt-1 . . . Alt-7)	●	●	●
Switch LU (Alt-W)	●	●	●
Specify LU (Alt-L)	●	○	○
Hot key (Alt-Esc)	●	●	●
Exit (Alt-E)	●	●	●
Resident (Alt-R)	●	●	●
Windowing	●	●	○
Macro keys	●	●	○
Command mode	●	○	○
Switch keyboard (Alt-K)	●	○	○
On-line help (Alt-H)	●	○	○
DOS directory (Alt-D)	●	○	○
Cut and paste	●	○[a]	○[a]

[a] *Stand-alone version available.*

The MiniLink package includes a choice of three memory models: small (10KB), medium (25KB), and large (40KB). Printer-support features are available in all models. Cut-and-Paste can be added to the small or medium versions.

settings are memory address at C000H, I/O address at 350H, and signal line not terminated. Memory addresses can be C400H, C000H, E000H, or E400H. I/O addresses can be 350H, 340H, 330H, 270H, 260H, or 250H. The board required one full-length slot.

Software installation was just as easy. Two methods are given for software set-up within the network. The first method puts all gateway software in the network-server PC, with each slave workstation accessing this information. The second method allows each workstation to change its emulation parameters but not its terminal type. Easy-to-follow, detailed steps are provided for each procedure.

Configuration is exceptionally easy: a standard configuration usually can be completed in a matter of minutes. All options are menu driven and resemble the familiar vertical-bar menus. Pop-up menus also are used for device selection. Key-click and beep volume are adjusted using Macintosh-like slide bars. However, no obvious support is included in the configuration for the IBM enhanced keyboard, although support could be available by the time this review is published.

The MiniLink package also provides a choice of three memory models: small (10KB), medium (25KB), and large (40KB). (See table 2 for a list of features available with each of these memory models.)

The MiniLink gateway also has the ability to run in either dedicated or nondedicated mode; a gateway running in the nondedicated mode reduces overall gateway performance. The procedure for starting the gateway is similar for both modes and requires only two or three commands to be entered from the keyboard.

The Alt-Space key sequence places the user in the emulation command mode. In this mode, the user can access Window, Session, and System commands by means of a user-friendly window system. The command mode allows the user to resize, move, scroll, zoom and unzoom windows, switch between sessions, inspect the disk directory, change keyboards, view the printer panel, and make the emulation software resident.

A cut-and-paste feature, standard in the large version of MiniLink, copies a block of emulation screen and stores it in memory, later retrieving and placing it into any PC application program or MiniLink session. A stand-alone version of the cut-and-paste feature can be added to the small or medium memory versions of MiniLink.

The Asher board performed exactly as the literature claimed it would. All features worked impressively. However, the board suffered from the same problem as the AST board in that it was sluggish during rapid typing.

AST Research, Inc. The AST 5250 Gateway is actually software that enhances the operation of the AST 5251/11 or 5251/11 Plus board. The Gateway software can be purchased together with the board or as an upgrade for current AST-5250 owners. A remote version of both the emulation board and the gateway software is also available.

On April 2, IBM made PC history. Eight weeks later, we rewrote it.



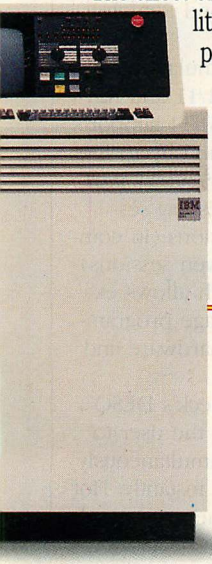
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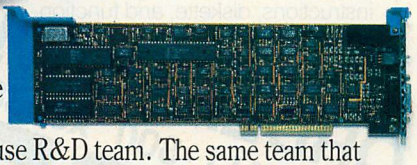
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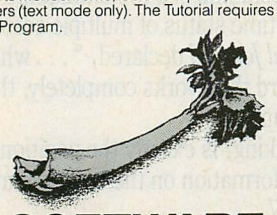
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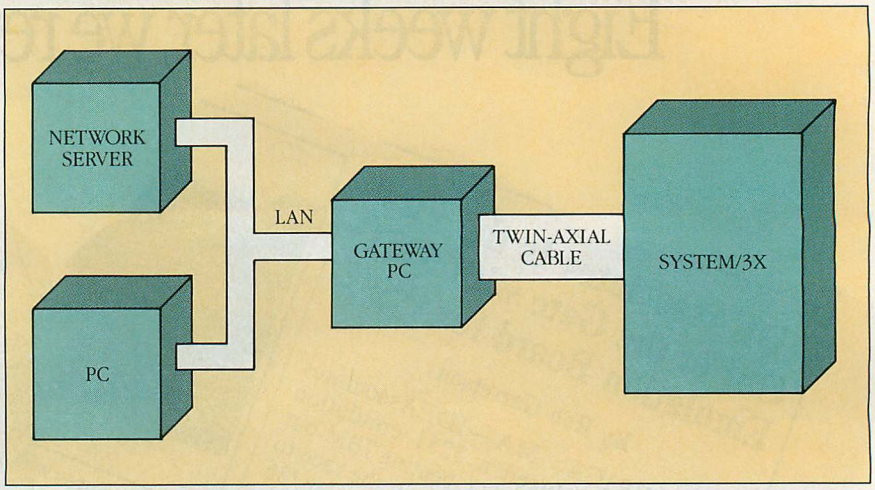
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FIGURE 1: *AST-5250 Gateway Configuration*



The gateway can be set up in various configurations. This configuration, showing PCs communicating with the System/3x through a LAN gateway PC, is typical.

The possibilities inherent in the AST package seem endless. Figure 1 shows one possible configuration. Set-up is definitely not for the novice—a sound understanding of the various arrangements is essential. The package can support a maximum of three gateway PCs on a single network, allowing as many as 21 slave PCs to access System/3x sessions simultaneously. Slave PC printers can emulate any printer supported by AST-5250 emulation products.

Configuration is entirely menu driven with familiar Lotus-style horizontal menus. A quick-configuration program helps speed the configuration process. Security can be added requiring passwords to access the configuration menus or for remote access to the host. Cable-through or line termination is selected by a jumper located on the card itself. The user who has IBM's Token-Ring hardware will need to change the interrupt level on the Token-Ring board (only on the Gateway PC) because it conflicts with the AST 5251 card.

The Gateway software contains three individual pieces of software: KERNEL, GATE5251, and APS. KERNEL requires 90KB of memory and provides support for the twin-axial cable, SNA/SDLC, AST-5250 asynchronous, or the AST-5250 NETBIOS protocol; display and printer emulation; and the application-program interface (API). GATE5251 requires 75KB of memory and provides the routines for sharing sessions with other PCs. APS (Application Presentation Services), requires 70KB of memory and transfers information to and from the user.

Each slave PC requires the APS and KERNELGW. The latter requires 120KB of memory and supports the 5250-NETBIOS protocol, display and printer emulation, and the API.

KERNEL in the gateway communicates with the System/3x and maintains the host connection. The APS controls the PC keyboard and memory. In addition, the gateway and slave PCs require additional memory for any additional drivers such as IBM's Token-Ring driver (TOKREUI) and NETBIOS.

Although the manual is not clear, it is absolutely essential to thoroughly understand the Base Manual included with the AST-5250 program. AST offers several software products that use the same or a similar configuration program; understanding the various options can greatly reduce the amount of time needed in configuration. The Base Manual also refers to various other AST Research software products, such as Cluster, Asynch Clusters, and Remote, and their functions.

Two models of the emulation card are available: the AST-5251/11 and AST-5251/11 Plus. The AST-5251/11 supports only one display session and up to five printer sessions. The AST-5251/11 Plus supports as many as six display sessions and five printer sessions (in combination not to exceed seven sessions). Both include an API, which allows experienced assembly-language programmers to access the 5251 hardware and software directly.

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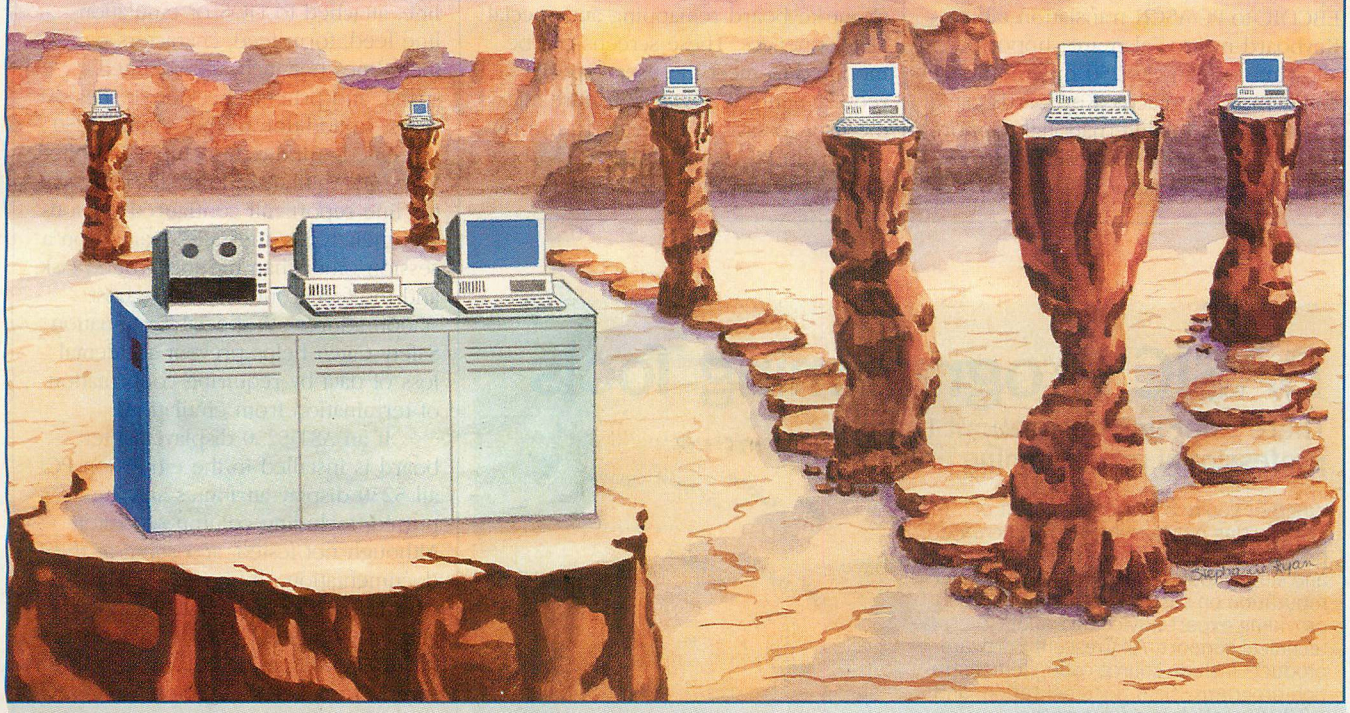
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the sessions (Alt-Esc) or to switch between emulation and DOS (both shift keys together).

The printer-support software can be fine-tuned by changing constants to optimize the performance of parallel printers. Each printer can have its own EBCDIC-to-PC/ASCII translation table. Keyboard macros also are supported, allowing as many as 250 mnemonic codes for each macro. Keyboards can be remapped for international support.

AST also provides additional security above the System/3x level; passwords can be assigned to emulation programs, configuration programs, and hot-key sequences. A special automatic sign-on feature enables all configured display sessions to sequence through multiple emulation tasks upon start-up.

Help screens provide information about keyboard remapping and special key sequences. These screens can be modified to meet the user's special requirements. A *snapshot* feature allows the user to save as many as 10 display screens in PC memory. These can be recalled at any point, or eventually saved to PC disk files using SNAPDUMP.EXE from the DOS mode.

Text, *diacritic* mode, and hexadecimal mode are supported. A special printer-status menu provides a convenient way to report and select printer characteristics such as host on- or off-line, attached to DOS or emulation, line feed, form feed, characters per inch, lines per inch, user-defined string, and printer check-error messages. In addition to the regular 5250 screen-edge indicators (Input Inhibited, Message Waiting, and the like), the status line reports all configured sessions and their types; messages waiting on a session other than the foreground task; and the foreground session's host-station address. A special Termination Safety Catch helps prevent accidental loss of data by requiring confirmation of termination from emulation.

If an AST-5250 display-adapter board is installed in the emulation PC, all 5250 display attributes are supported, including column separators. Although not tested, according to the documentation, the board is compatible with PC Support/36 and PC Support/38 and File Support Utility for System/34/36/38. Pressing a hot-key combination saves and restores all graphics memory on a display adapter compatible with Lotus 1-2-3 graphics.

Two configuration programs are included with the package: CFG5251 for the master gateway and CFG5251G for each slave PC. Both configuration programs appear identical except for a few minor differences. Emulation of IBM 5251 Model 11, 5291 Models 1 and 2, and the IBM 5292 Model 1 terminals is supported. Supported printers are the IBM 5256 Models 1, 2, and 3, the IBM 5224 Models 1 and 2, the IBM 5225 Models 1, 2, 3, and 4, and the IBM 5219 Models D01 and D02.

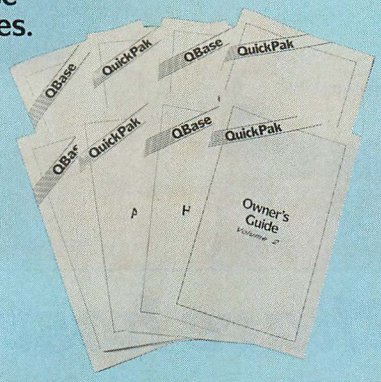
The documentation is lengthy—the product has so many options that about 120 pages is devoted to software configuration. But in spite of all the information provided, many terms are not defined. For example, the configuration documentation gives no explanation of the difference between gateways and clusters. Yet, one of the first questions the configuration program asks is whether the configuration is for a "master cluster." Only in the Base Manual is a master cluster identified—as a completely separate product.

Various keyboard layouts also are supported, including the IBM enhanced keyboard; however, the mapping for the enhanced keyboard is different from that provided by IBM's 5251 emu-

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lation package. Despite this, the keyboard can be remapped to individual needs using the configuration program.

In testing, the gateway emulation did not operate at first. The standard procedure was to load IBM's Token-Ring driver, TOKREUI, then ANET3 for the Novell Network, followed by NETBIOS, KERNEL, GATE5251, and APS. It finally was discovered that the gateway would not perform when ANET3 was loaded. When ANET3 was omitted from start-up, gateway emulation was totally successful.

However, the product performed sluggishly, most likely because of the amount of network activity. Some speed may have been lost by using an XT instead of an AT as the master gateway, but this loss is small when compared with network overhead. Keystrokes were not displayed instantaneously; a fast typist could actually type five or six characters before they were displayed on the screen. When an error locked the keyboard, the Error Reset key had to be pressed for several seconds before the error was reset.

IDEAssociates. The IDEAcomm 5251 emulation board addresses the gateway in a manner totally different from the other two products. Each PC is attached to the gateway PC using RS-232 cable instead of a LAN. Although this type of connection is much less flexible, the board does exactly what the manufacturer claims and with practically no problems. The IDEAcomm itself is simple to install—the installer merely opens the PC, inserts the card, and closes the PC. Its single-line terminator is accessible from the rear of the PC; the other boards reviewed have jumpers on the cards that must be set before insertion.

Additional PCs attach to the gateway using a separate software package called IDEAcomm 5251/Share. The IDEAcomm 5251 board includes the software needed to run local emulation for a single PC. The standard 5251 package allows one PC to emulate up to four host sessions; windows are supported so that all four sessions can be viewed simultaneously. When the Share software is added, these four sessions can be distributed among three additional PCs. For those who already have the IDEAcomm 5251 board, the Share software is available as a stand-alone software product.

By using RS-232 cable instead of a network to attach each PC to the gateway, no network hardware, software, or overhead is required. The only hardware required is an RS-232 port for each PC to be connected. The board reprograms the RS-232 controller to communicate effectively at 115K bps (rather than the normal 9,600-bps limit); absolutely no degradation in response time was observed at any of the attached PCs. The POP test performed at full speed on both the gateway and the slave PCs.

This board supports either four concurrent terminal sessions, or three terminal sessions and one printer session. The printer session is not restricted to the gateway PC and can reside on any of the attached PCs. Each slave PC can request up to two sessions from a pool of unused sessions. Each PC can emulate either two terminals, one terminal and one printer, one terminal, or one printer. On the slave PCs, 5251-11, 5291, and 5292 terminals and 5219, 5224, 5225, and 5256 printers are emulated.

An on-board processor on the card performs all communication functions. When the gateway was put into PC mode, the slave PCs continued to perform with no sacrifice of speed. The

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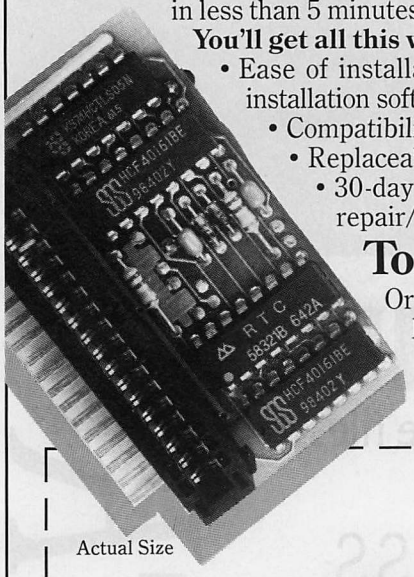
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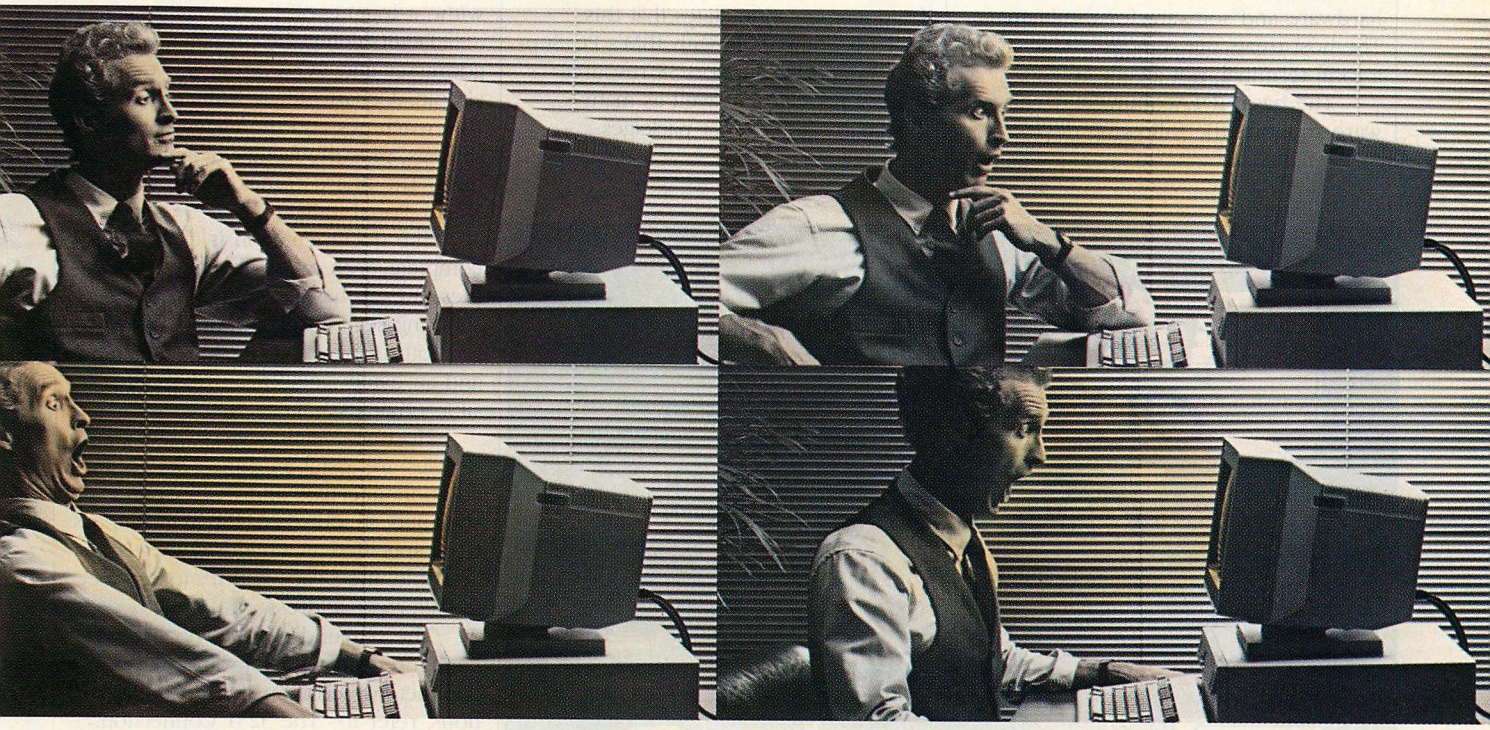
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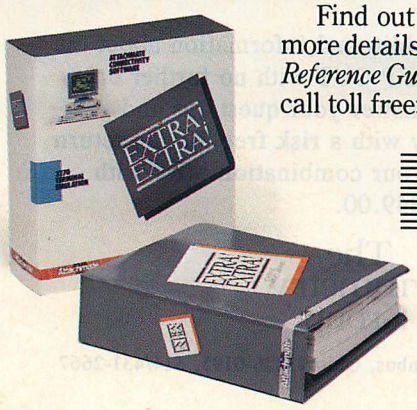
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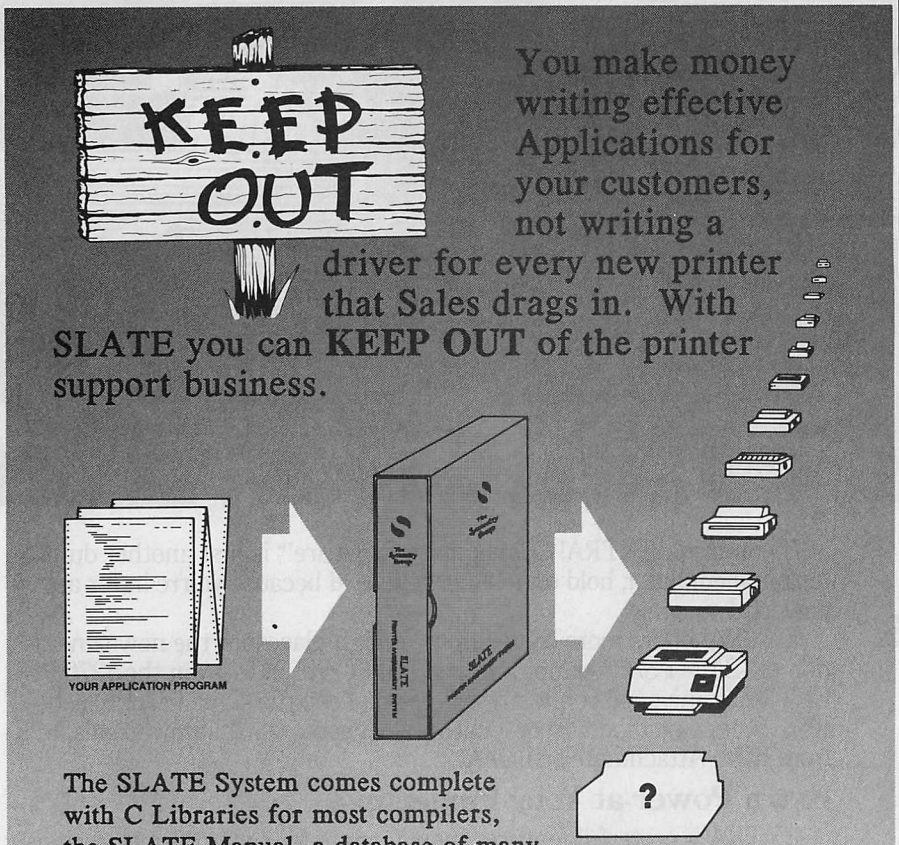
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gateway PC also performed as a PC with no speed loss while the other PCs were operating simultaneously.

One outstanding feature of IDEAcomm is its ability to assign one of the sessions to a 1,200-bps modem. This allows a remote PC to communicate with the gateway by modem, thus eliminating expensive communications hardware and software for the host. The host treats the remote device like a local terminal, not a remote.

The basic IDEAcomm 5251 software supports the following device types: 5251-11, 5291-11, 5292-1, and 3180-2. The supported printers are the 5224-1, 5225-1, 5256-1, and 5219. A local printer can be configured to print graphics from 5292 emulation. Window functions allow the user to view four sessions at one time, to turn windows on and off, and to resize windows. Although not evaluated for this article, the documentation states that this board is compatible with IBM's PC Support/36 and PC Support/38 resource-sharing packages, as well as many third-party file-transfer packages.



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The board hardware was designed specifically to allow it to work independently of direct-memory access (DMA) channel resources, thereby eliminating any conflict between 5251 hardware and hard disks or other hardware devices that use DMA channels. A predefined hot key is used to switch between PC mode and System/3x mode without logging-off the host.

Determining the proper memory addresses and I/O addresses is quite simple. A chart indicates the various IBM machines and the necessary switch settings, plus the factory default settings. The board comes set up for a PC, XT, or Portable PC.

The documentation is clear and complete, with many illustrated examples. It even has a complete trouble-shooting section, diagnostic routines for both display and printer emulation, and an extensive section listing all possible error messages.

Host workstation and printer addresses are assigned during set-up. In addition, alternate addresses can be specified; if address 0, for example, has been specified as an address but is not available, the board will try to reserve the alternate address.

The remainder of the board is configured through software. (For a complete description of emulation options, refer to "The 5251 Connection.") The package supports various keyboard layouts, including the new enhanced-keyboard layout. Although the board has no utility to define an individual layout, IDEAssociates says it will configure, at no charge, any keyboard layout required by a user if it is not available in the standard package. An included utility allows the gateway to monitor what is occurring at the various sessions. Every keystroke that appears on the monitored workstation also appears on the gateway.

IDEAcomm is extremely easy to configure and use. Total installation took about 20 minutes, including removing and replacing the machine covers. The software configuration is very straightforward and includes little, if any, technical jargon. The IDEAcomm Share option is a flexible, reliable way to connect up to three additional PCs sharing up to four System/3x sessions.

GATEWAY TO WHERE?

A 5251 gateway should be evaluated seriously before being added to a System/3x environment. The gateway is a feasible solution for companies suffering from host inaccessibility in existing networks.

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Max. Number of Array Dimensions	255	63	8
Max. Number of Elements/Dimension	UNLIMITED	32K	32K
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Matrix I/O Statements	YES	NO	NO
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Total String Space	UNLIMITED	64K	64K
Maximum Record Size	16MB	32K	32K
Max. Bytes/Binary File Read	64K	NA	32K
PRODUCTIVITY ENHANCERS			
Modules	YES	NO	NO
Separately Compiled Libraries	YES	LIMITED	NO
Workspaces	YES	NO	NO
Immediate Mode	YES	NO	NO
SPECIAL FEATURES			
Stop/Continue Execution	YES	NO	NO
Max. Source File	UNLIMITED	UNLIMITED	64K
Script Files	YES	NO	NO
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Max. Characters/Line	64K	255 char.	249 char.
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CIRCLE NO. 207 ON READER SERVICE CARD

GATEWAYS TO SYSTEM/3X

No board should be evaluated solely by its number of features; the important features to look for are response time, display speed, keyboard mapping, and number of available sessions. Many users are not interested in learning the fancy features offered by many of the current emulation products. Most of these are used only by technical programmers who understand their potential. Users first must understand their needs before purchasing this type of hardware.

Another aspect to consider is the advantage of address bidding, which is available on networks but not on dedicated terminals. In address bidding, as many PCs can be hooked together as will fit on the network; each can access the host, provided the host has a free address for it. This arrangement is still limited to the number of sessions the gateway allows. However, once a user signs off, that station address is available to another user, perhaps in another location. Although this is a great idea, in System/36 environments users usually do not sign off the system until they leave for the day (and sometimes not even then).

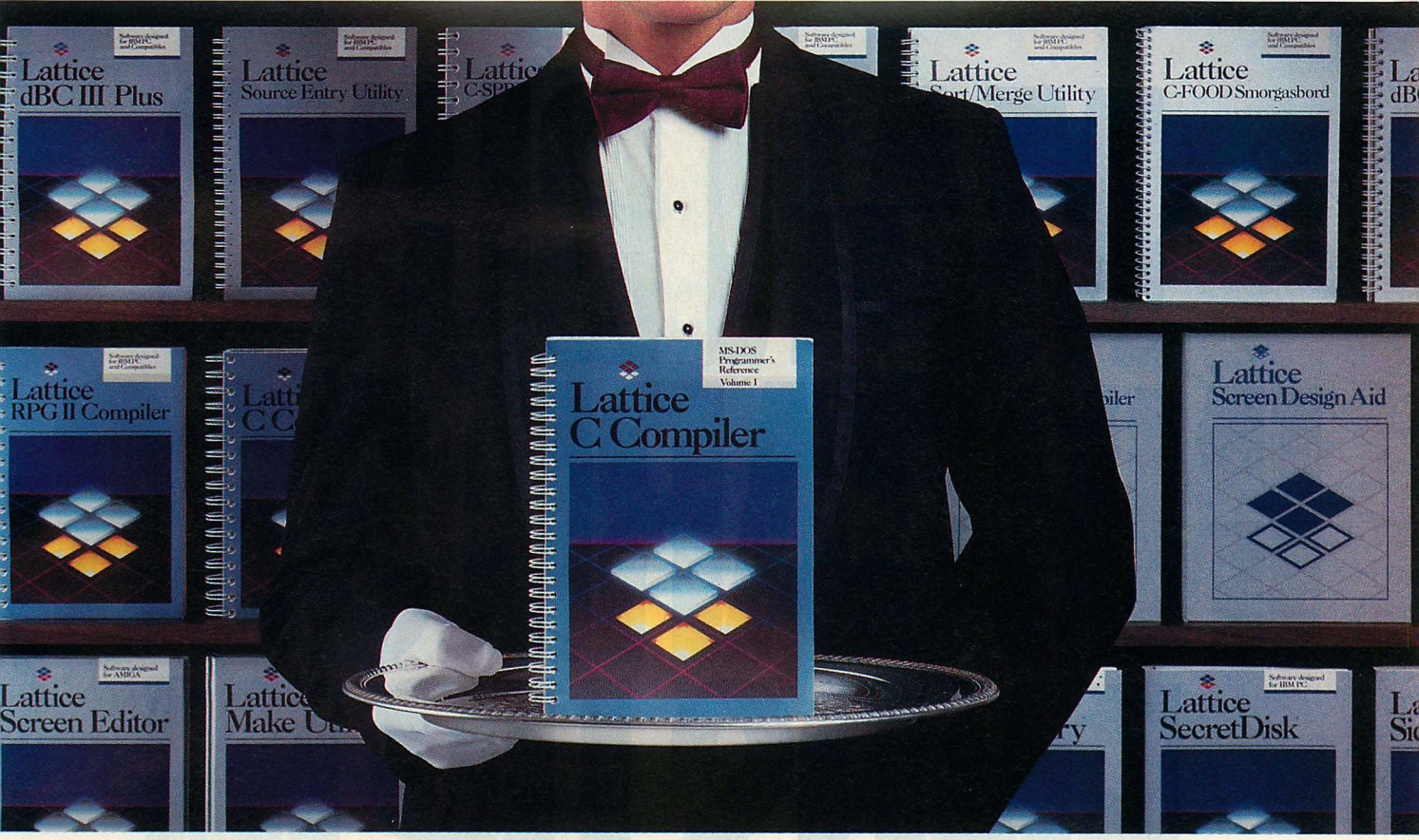
Of the gateways tested, the AST and Asher boards seem too sluggish for a serious development facility. In a data-acquisition environment, however, either might be an effective solution. With IDEAcomm, the displays responded instantly and caused no sacrifice of speed in the server PC. The IDEAssociates board, used with its Share software, is a great solution when two or three additional terminals are needed and the PCs are already installed with serial cards.

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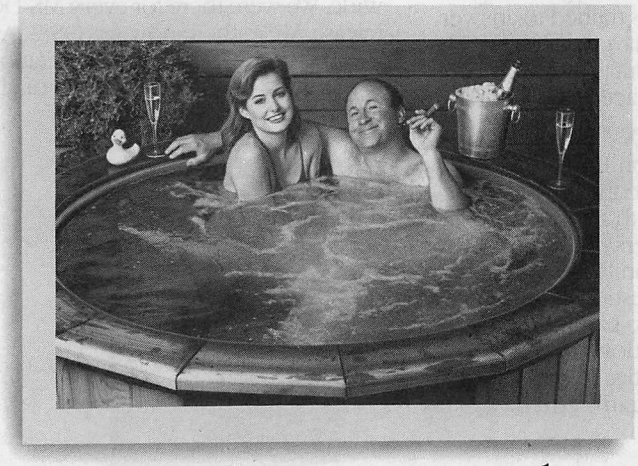
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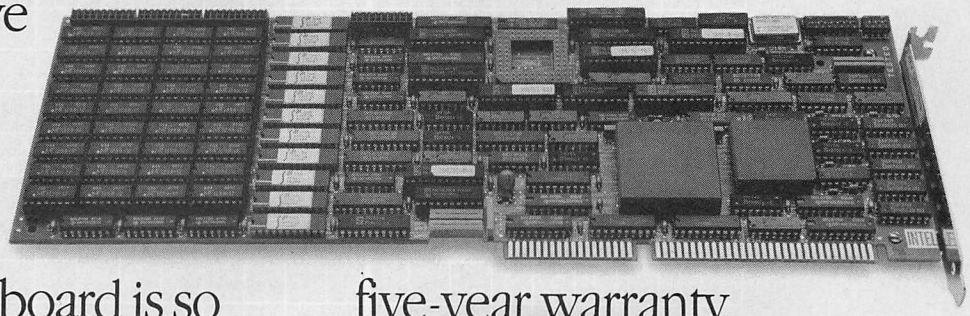
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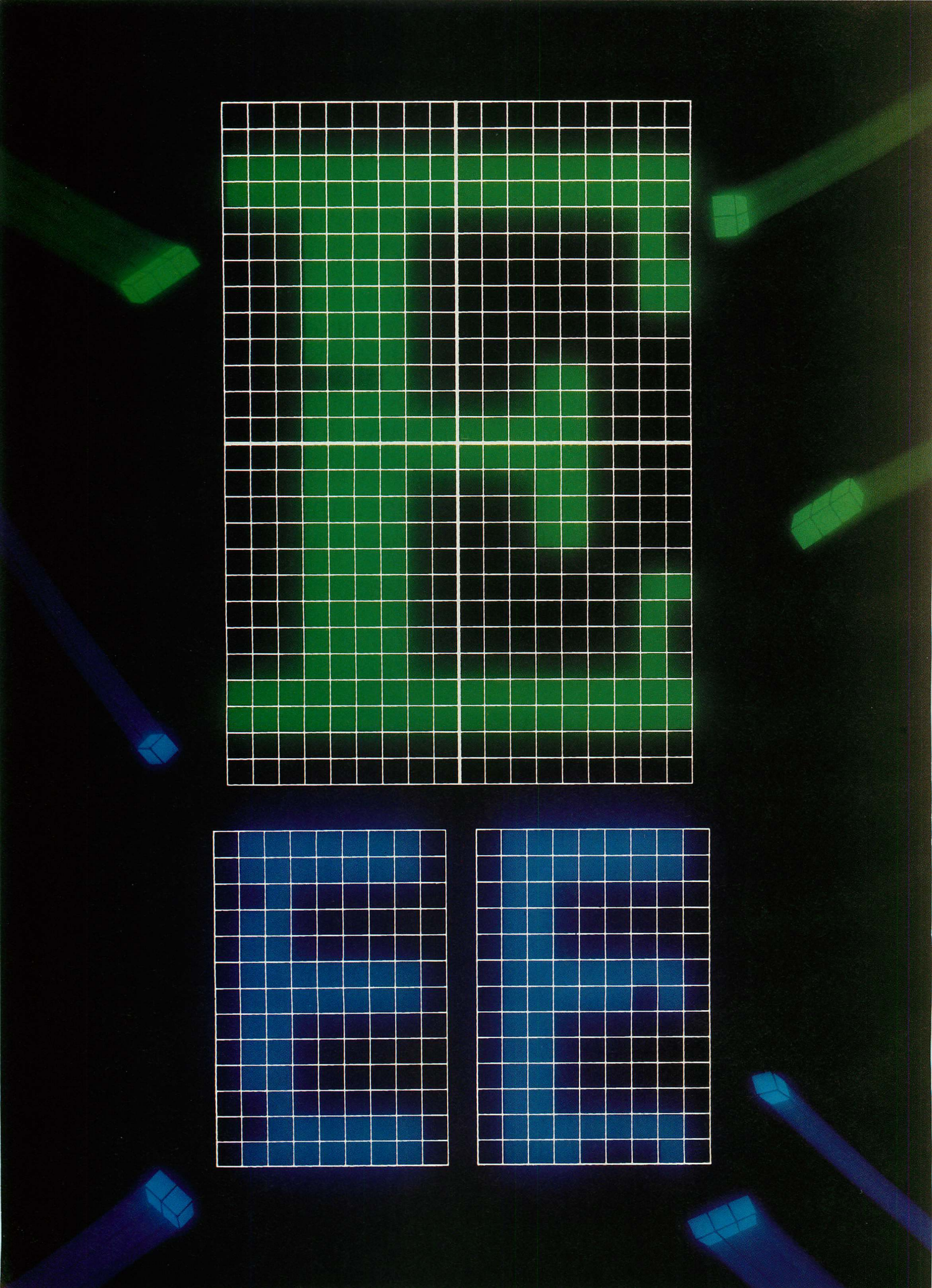
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CIRCLE NO. 187 ON READER SERVICE CARD



Multiple Fonts

Hercules' Graphics Card Plus with RamFont and InColor Card can display multiple fonts simultaneously in text mode, enhancing the monochrome standard.

JOHN T. COCKERHAM

The Hercules graphics card had barely made its debut in 1982, when it became the monochrome adapter of choice. It had the following advantages: It was inexpensive, emulated the IBM Monochrome Display Adapter (MDA), and had additional modes that provided graphics at a resolution that was higher than that of the IBM Color Graphics Adapter (CGA). Many popular software packages could use the drivers supplied by Hercules. In addition, other companies could write their own drivers.

When IBM ushered in the Enhanced Graphics Adapter (EGA) in 1984, it constituted a direct challenge to Hercules' popularity. The EGA provided three-color monochrome graphics (low intensity, high intensity, and blink) and could be reconfigured to drive a color display. Many other manufacturers were quick to introduce enhanced EGAs as well. Some, such as Video 7's VEGA Deluxe, provided emulation for the Hercules monochrome standard in addition to the EGA capabilities. (For more information, see "Evaluating the EGA: The EGA Standard," "The EGA Spectrum," Part 1 and Part 2, John T. Cockerham, October 1986, p. 48 and p. 80, and November 1986, p. 147, respectively.)

Despite these new offerings, the Hercules monochrome adapter has retained its high standing. EGA boards simply have established a second standard in the field. Now that these two standards are in place, PC monochrome display adapter technology has reached a plateau at which it has remained for several years.

But Hercules has not been content to stand still since it established the standard for monochrome graphics adapters. To improve upon the monochrome standard, and to propose a new medium-resolution color graphics standard, Hercules has introduced two new products: the Graphics Card Plus with RamFont and the InColor card with RamFont. The boards are shown in photos 1 and 2, respectively.

The Graphics Card Plus is targeted at addressing some of the deficiencies of monochrome displays for word processing and desktop publishing—especially with regard to the inability of these monochrome systems to display more than one font at a time on the screen. This problem is handled by allowing a font to be defined in the RAM on the adapter—the font is called a *soft font*. The RAM then is used like a character-generator ROM to obtain the font information to be displayed.

Using this Graphics Card Plus with RamFont, a program can display simultaneously as many as 12 different soft fonts on the screen in a nearly standard monochrome *text* mode (approximating that of the IBM Monochrome Display Adapter). Programs also can use the standard Hercules 720-by-348 graphics mode, use the standard text mode with a single soft font, and combine all-points-addressable (APA) graphics and text while the board is operating in text mode.

The advantage of the increased number of fonts is obvious: a word-processing or desktop-publishing application can present the user's choice of fonts on the screen. (The use of a soft font in desktop publishing is restricted, however, as text mode does not allow the representation of proportionately spaced fonts.) The speed that is gained in running the board *in text mode* instead of in graphics mode is an invaluable fringe benefit.

The novel APA feature of the Graphics Card Plus allows it to mix text and graphics on a screen, but it cannot do so in an independent *hardware-defined* window. In the past, in order to blend graphics and text, it was necessary to put the particular adapter into a graphics mode and to paint glyphs

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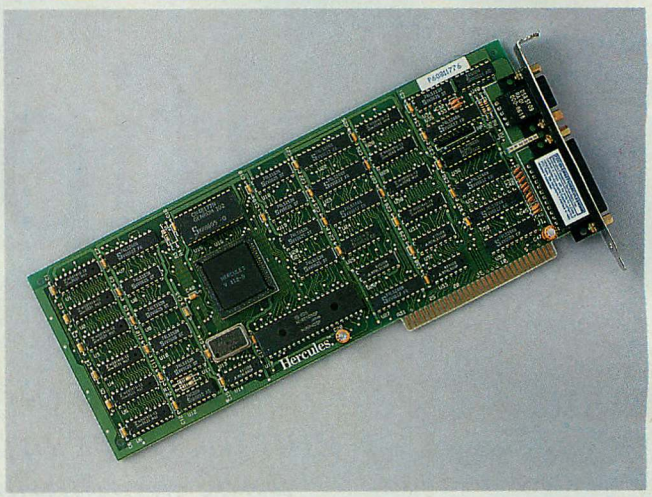
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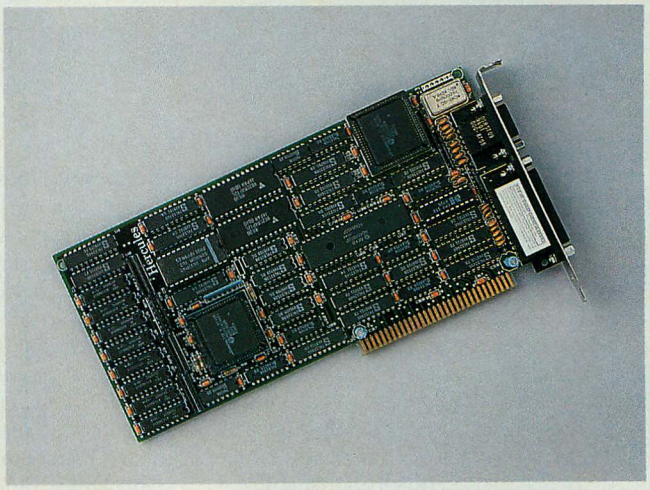
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PHOTO 1: *Graphics Card Plus*



Display adapters with RamFont have standard text mode, as defined for the IBM Monochrome Display Adapter.

PHOTO 2: *InColor Card*



InColor card's pixel-handling features are functionally the same as EGA's but contrast sharply in execution.

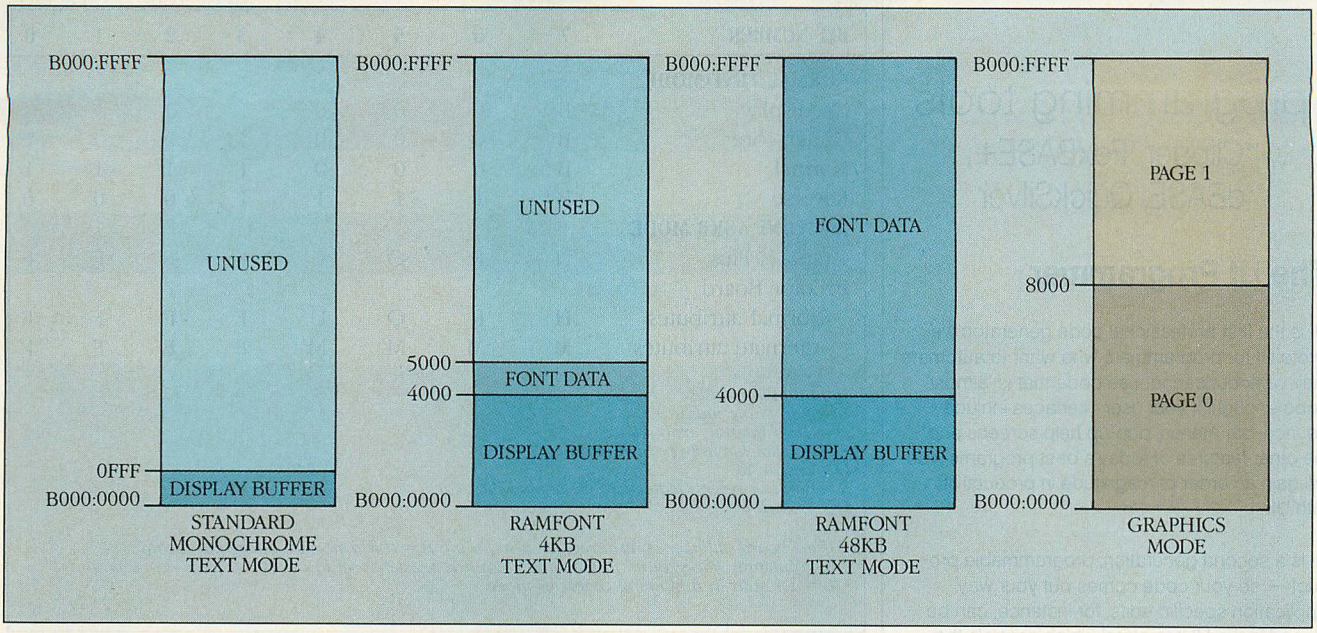
PHOTO 3: *HERCDEMO Program Output*



The graphics "window" is inset into the text. The adapter is operating in text mode.

CIRCLE NO. 244 ON READER SERVICE CARD

FIGURE 1: *Memory Mapping for Hercules Graphics Cards*



The text and graphics modes for the card retain the original Hercules memory-map definitions. The new modes, RamFont 4KB and 48KB, map the font data into display RAM, rather than using a ROM outside the CPU's address space.

(that is, the individual characters) a pixel at a time. With Hercules' new display architecture, the distinction between graphics and text modes is becoming muted. By accessing the areas of RAM in which a font is defined, the programmer can mix text and graphics on the screen while the adapter operates in text mode, which offers an inherently faster performance than does the graphics mode.

Hercules also has leaped into the color graphics arena with the InColor card, which can emulate the MDA or can be run in color. The following modes are available: text and APA graphics modes that are compatible with the Hercules monochrome board, and the RamFont 4KB and RamFont 48KB modes that also are resident on the RamFont board.

The InColor adapter is like the EGA in that both of these boards provide 16-color graphics using four parallel bit planes, but it is here that any similarity between them ends. The InColor adapter can drive only a digital color display, not the monochrome display supported by the EGA. Unlike the EGA, the InColor adapter always appears to the host computer's BIOS to be a monochrome adapter: it occupies the monochrome display RAM address space, and the BIOS on the motherboard can manipulate the adapter by using monochrome I/O instructions. The InColor card's pixel-handling features are functionally the same as the EGA's but contrast sharply in the manner in which they are executed.

ARCHITECTURE AND FEATURES

With the introduction of RamFont, Hercules has increased the number of fonts available to applications. The Graphics Card Plus and InColor boards provide two new "text" modes in addition to the standard MDA text mode; these new modes are the RamFont 4KB and 48KB modes (the names indicate the amount of RAM available to store the soft fonts). The RamFont modes of the two new adapters are nearly identical. The only differences are extensions to the InColor card for the manipulation of color and the color bit planes. The Hercules graphics mode, 720 by 348, is also available and remains unchanged from the previous editions of the Hercules adapter.

Figure 1 illustrates the display buffer organization for the three text modes and the one graphics mode; these retain the original Hercules definitions. As shown in the figure, the two RamFont modes (4KB and 48KB) reserve additional space above the active display RAM for the soft fonts.

In standard text mode, all glyphs are painted into a fixed, 9-by-14-character cell on the screen. The character generator (the font) is located outside of the host CPU's address space, on a ROM chip mounted on the adapter. When the adapters operate in the RamFont modes, the character is generated from RAM instead of from ROM. Next, this soft font is mapped into the video display buffer. In either RamFont mode, the character cell for the font's glyphs no longer remains fixed but can be programmed to be 8 or 9 bits wide and from 4 to 16 rasters (scan lines) high, thus offering a maximum glyph size of 9 by 16 and a minimum glyph size of 8 by 4 (9 by 16 is obviously not a large enough size to create an ornate font and thus represents a rigorous restriction for the board in precisely the area in which its performance should be outstanding). It is possible to use this board to create larger fonts by assembling a character from several smaller characters.

In the 4KB RamFont, only one soft font is accessible. In 48KB mode, as many as 12 typefaces can be accessed—but all fonts defined at any one time must have the same height and width. A font occupies the same area of RAM, regardless of its size. In designing a font for all of the text modes, each raster line for a glyph is represented by one byte. Thus, the glyph is always eight pixels wide. When the board is operating in a mode that uses nine-pixel-wide character cells, a blank pixel is inserted between all glyphs, except after the ASCII graphical elements (codes 0B0H to 0DFH), in which the eighth pixel is replicated into the ninth one in order to allow the elements to connect on the screen. The designer of an eight-dot font must

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TABLE 1: *Attribute Byte Definitions for All Modes*

BIT NUMBER	7	6	5	4	3	2	1	0
NORMAL TEXT MODE								
No display	B[a]	0	0	0	I	0	0	0
Underscore	B[a]	0	0	0	I	0	0	1
Normal	B[a]	0	0	0	I	1	1	1
Reverse	B[a]	1	1	1	I	0	0	0
RAMFONT 48KB MODE								
Graphics Plus	H	R	O	U	F	F	F	F
InColor Board								
Normal attributes	H	R	O	U	F	F	F	F
Alternate attributes	M	M	M	M	F	F	F	F

B = Bit plane masks
F = Font plane masks
H = High intensity or boldface
I = Normal intensity or high intensity
O = Overstrike
R = Blink or reverse video with the blinker bit clear
U = Underline

[a] *If the board's blinker control register is set to off: B = 0 is a normal background and B = 1 is a high intensity background. If the blinker control register is set to on: B = 0 gives no blink and B = 1 results in a blinking character mode.*

The attribute byte for the RamFont modes does not function identically to the one on the IBM Monochrome Display Adapter.

include a column of blank pixels on the right-hand edge of the glyph to allow for character separation on the screen. This procedure renders the usable size of an eight-dot font effectively only seven dots wide.

The Graphics Card Plus contrast with an EGA in monochrome mode in several key areas. The Hercules boards have more fonts (12), and all fonts can be displayed simultaneously, whereas the EGA can have only two of four fonts active at any one time. (IBM's new Video Graphics Array, which is an extension of the EGA, has this very limitation.) To produce the extra fonts, however, Hercules has sacrificed attribute byte compatibility with previous adapters in the RamFont 48KB mode.

In standard text mode, the board operates with the standard monochrome character attributes (normal, blink, high intensity, blank, reverse, and underline). The InColor card offers extensions to the set of attributes that manipulate the foreground and background colors. RamFont 4KB mode operates in a similar fashion, with the font data retrieved from display RAM.

The coding for the attribute bytes is different, depending upon the RamFont mode. In 4KB RamFont mode, the attribute byte is compatible with previous monochrome adapters, when using the same bits to set each of the attributes. In 48KB mode, however, the attribute byte is not compatible with previous monochrome adapters—in this mode, the low four bits of the attribute byte specify the font, and the upper four bits have different meanings, depending upon the blink bit setting in the board's control register (I/O address 3B8H bit 5). Table 1 summarizes the attribute bytes for all text modes.

In RamFont 48KB mode, the following two new attributes are introduced: overstrike and boldface. Overstrike places a line of pixels in the middle of the character cell so that the characters look as though they have been struck out. The overstrike line is controlled by the programmer. The CRTC register **xStrikeReg** exerts control over which raster line is the overstrike. Boldface directs the board to duplicate the pixels of the font into the next adjacent pixel column (to the right), thereby effectively doubling the weight of the font. Boldface is useful only in single-stroke fonts—that is, those fonts in which the glyphs are formed by single lines of pixels—because the amount of resolution available in a eight-pixel-wide font would not allow a font that has a double stroke to show adequate resolution.

Except for the RamFont 48KB mode, the boards maintain compatibility with previous Hercules adapters with regard to display buffer access and attribute byte interpretation. The standard text mode is the same as the one used by the MDA. The graphics mode maps one pixel per bit. Scan rows are interleaved in four groups in display



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RAM. (A description of mapping methods for scan lines in display RAM can be found in "Evaluating the EGA: The EGA Spectrum, Part 2.")

Both the EGA and the two Hercules adapters can define a font that is tall enough for any application when operating in graphics mode. In text mode, the EGA can define a font that is up to 32 pixels high, and the Hercules adapters can define one up to 16 pixels high. This is an insignificant difference from a practical point of view because of the width limitation (one of 8 or 9 bits). In graphics mode, the EGA is organized in a linear fashion—that is, the scan lines are placed consecutively in display RAM—which provides a full 350-line screen. The Hercules adapters paint only 348 lines, which causes the bottom two scan lines to be cut off in applications that do not have the expected performance.

The Hercules adapters' external I/O registers for mode setting have the same layout and I/O addressing as the Hercules Graphics Card Plus. The Hercules chip includes additional registers in the CRT Controller (that are extensions to the Motorola CRT Controller), allowing for programming of the RamFont modes and manipulating pixels and color in the InColor card.

Both of the Hercules adapters appear to the motherboard BIOS as standard monochrome display adapters. The display RAM for both boards is always mapped into the monochrome address space, at offset zero in segment B000H. Because of this, the adapter cannot be used with a monochrome adapter in the same system.

Both RamFont adapters will reside with a CGA, unless the RamFont adapters operate in 48KB mode, where an addressing conflict arises because the Hercules adapters provide a full 64KB of font space. To work with a CGA in 48KB mode, the RamFont cards must be placed in the half-page mode, which limits RAM addressing to the first 32KB. This mode restricts the number of fonts to four. The display buffer occupies the base of the memory, and the remaining room in the RAM is sufficient for four fonts. In the normal mode, the additional eight available fonts occupy the top 32KB of RAM.

INCOLOR EXTENSIONS

The InColor adapter is similar to the RamFont adapter, except for the fact that it has 16-of-64 color capabilities in both graphics and text modes. Color is represented with four parallel bit planes choosing 16 of 64 colors; this is a method akin to the one used by the EGA. At the monitor level, the InColor card is compatible only with digital color monitors, such as the IBM Enhanced Display or the NEC MultiSync monitor. None of the new Personal System/2 analog color displays *will* operate with this adapter.

All of the display modes of the Graphics Card Plus are available with the InColor card. RamFont modes are available with this card, although they may operate differently because of the presence of color. In RamFont 48KB mode, the four parallel bit planes each can store 12 fonts, yielding a total of 48. The attribute byte selects the font and the glyph's color. The attribute byte also chooses the display attribute (blink, bold, and so on). The individual bits of the byte set different functions, depending on the RamFont mode.

The graphics mode for the InColor card is the same as the one used for the Graphics Card Plus. The only difference here is in the introduction of color. In this card, the four parallel bit planes specify the color of each pixel in a manner similar to the color mapping used by the EGA.

Standard text mode operates in the same manner as the MDA. The attribute byte normally specifies blink,



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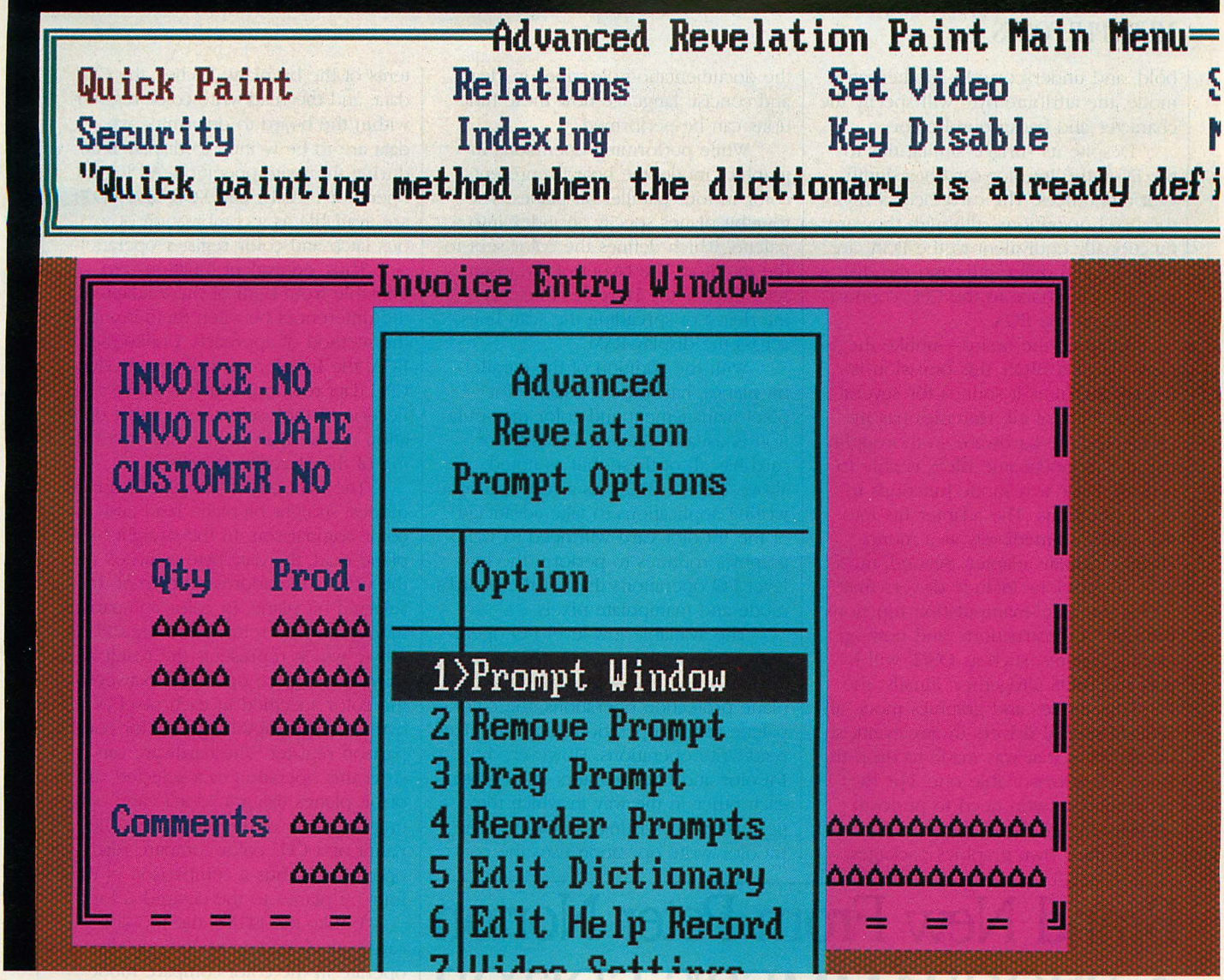
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bold, and underscore. In an alternative mode, the attribute byte will specify the character and background color.

Despite its surface similarities to the EGA, the InColor card has significant differences. The card lacks a BIOS; the pixel operations, although they are functionally equivalent to the EGA, are implemented differently; and the display RAM interface to the CPU contrasts with that of the EGA.

Although the board—unlike the EGA—lacks a BIOS, this omission is not so crucial as it sounds for several reasons. First of all, Hercules has implemented the hardware so thoroughly that the monochrome BIOS is able to provide basic text mode functions to the applications. The adapter fits into the system immediately as a monochrome display adapter. Second, most EGA applications include drivers that access the pixel-manipulation functions through I/O instructions, and new operating systems, such as OS/2, will bypass the BIOS altogether. Finally, the RamFont modes and graphics mode all require special drivers in any event, so the decision that was made to drop the BIOS was a reasonable one. For the programmers who need to perform special operations or for those who are writing their own graphics packages, the documentation describes in clear and concise language how these functions can be performed.

While performing operations in graphics mode, the board represents color in four parallel bit planes. The four bit planes specify an index into a palette, which defines the color sent to the monitor. The layout of the raster scan lines is the Hercules four-way interleave of spreading the scan lines across the display RAM.

With the addition of the parallel bit planes, hardware assistance for pixel management and color manipulation is usually needed. The InColor card has all of these, but as noted above, lacks a BIOS. As a result, anyone writing applications to take advantage of the InColor card will need to write graphics routines to perform the low-level I/O operations that set the board's mode and manipulate pixels.

The available low-level I/O operations are complete and mimic the repertoire of the EGA—including the bit plane protection operations, the color palette setting operations, and the pixel read/write operations. However, the InColor and EGA adapters differ from each other in the way in which they perform pixel-writing operations. The InColor write operation uses the contents of the bit plane latches, the CPU data, and the read/write color register within the board to determine what data are to be written to display RAM during the write operation. All logical operations (AND, OR, XOR, and NOT) are available as a combination of various latch and color register operations.

Thus, equivalent functions are available from both of these adapters, the differences between them being in the method of approach. Unlike the EGA, the InColor card does not offer CPU data rotation, which is more a reflection of the uselessness of that operation on the EGA rather than of a failing of the Hercules boards.

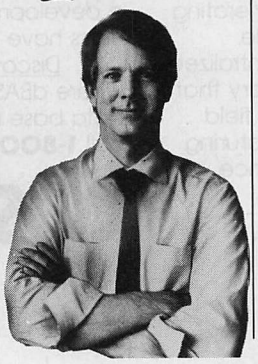
The EGA offers two pixel-read modes: straight bit-plane read and color comparison. In the straight bit-plane read, the data byte returned to the CPU is the addressed byte of the selected bit plane. In color comparison mode, the data returned to the CPU is a byte which represents the result of a bit-wise compare operation between the color specified in each pixel of a byte of display RAM and a color comparison register. The hardware can restrict this operation to a selected subset of bit planes using a "don't care" setting for some of the bit planes. The result of a CPU color-compare read operation is thus a comparison of the four bit planes to the desired color.

Unlike the EGA's, the InColor card's pixel-reading operations always operate in the color-compare mode. Sampling of an entire bit plane, which is of importance for the preservation operations of windowing software, is a subset of the color-compare operation. This is accomplished by comparing a selected bit plane to the value of 1 and putting the remaining bit planes to the "don't care" setting.

PROGRAMMING RAMFONT

When it added the new RamFont modes, Hercules abandoned the Motorola 6845 CRT Controller for its boards and adopted, in its place, a custom VLSI chip. The CRTC registers of this new chip are identical to their counterparts on the old board. In addition to the 17 registers normally found in the 6845 CRTC, three new registers have been added for controlling the RamFont modes. The new registers control the following items:

- The fonts and the width of the fonts (xModeReg CRTC index 14H)
- The scan line for underscore (xScoreReg 15H)
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The InColor card provides additional operations for manipulation of pixels and color setting.

Most of the CRTC registers have not changed either in format or in operation from the Hercules boards to the new boards. The format of the original Hercules mode register (3B8H) has remained unchanged. The status register (3BAH) has two new bits—one of them is used to detect the presence of the Graphics Card Plus, and the other one is used to detect the presence of the InColor card.

The majority of the registers are, unfortunately, write only. Mouse drivers and other applications that need to change the I/O registers during an interrupt (when an application program may be manipulating the registers) will be required to provide a shadow map interface that preserves the state of the various registers, especially with respect to the InColor card.

Programming the new Hercules cards is a fairly straightforward task. Tables that appear in the back of the technical reference manuals included with the cards list the CRTC parameters for all possible font widths and lengths. All due caution should be exercised when programming any CRTC; this is particularly crucial when the CRTC is attached to a monochrome display. The programmer must interrupt the video signals going to the display by clearing bit 3 of the display control port (3B8H) in order to prevent a partially programmed CRTC from accessing the monochrome display.

With the need to program modes directly into the new Hercules cards comes the potential for destroying the monochrome display. This type of display is very sensitive to incorrect vertical and horizontal synchronization signal timings, and programming an incorrect CRTC setting may result in damage to the monitor. It cannot be overemphasized how important it is to be certain of the CRTC parameters before executing a program that changes them for a monochrome display.

PERFORMANCE

In this era of increased sensitivity to performance, the Hercules cards prevail in several key areas: the adapter operates in text mode, and Hercules has taken steps to decrease display RAM contention. Because text mode can now display multiple fonts, word processors will be able to paint a variety of fonts quickly. With the adapter operating in text mode, two byte accesses to display RAM—one for the character code and the other for the attribute—will specify the desired glyph. In contrast, when the EGA operates in graphics mode for multiple fonts, the program must paint the pixels on the screen for the desired glyph.

Hercules included additional circuitry in its chip set to increase the overall performance of its adapters. The soft fonts are stored in a bank of RAM that is separate from the display RAM itself. Therefore, in text mode, accesses to soft font data will not interfere with accesses to display RAM.

The demonstration program. One area in which the new Hercules adapters clearly surpass the capabilities of the EGA is in the creation of a graphics "rectangle" within text mode. This rectangle is not a true hardware window, but an artifice from the large number of soft fonts available from the Hercules adapters. All of the soft fonts are independently programmable. By individually manipulating the pixels of any glyph, the corresponding glyph on the screen will be changed everywhere it is displayed. Thus, the "graphics window"

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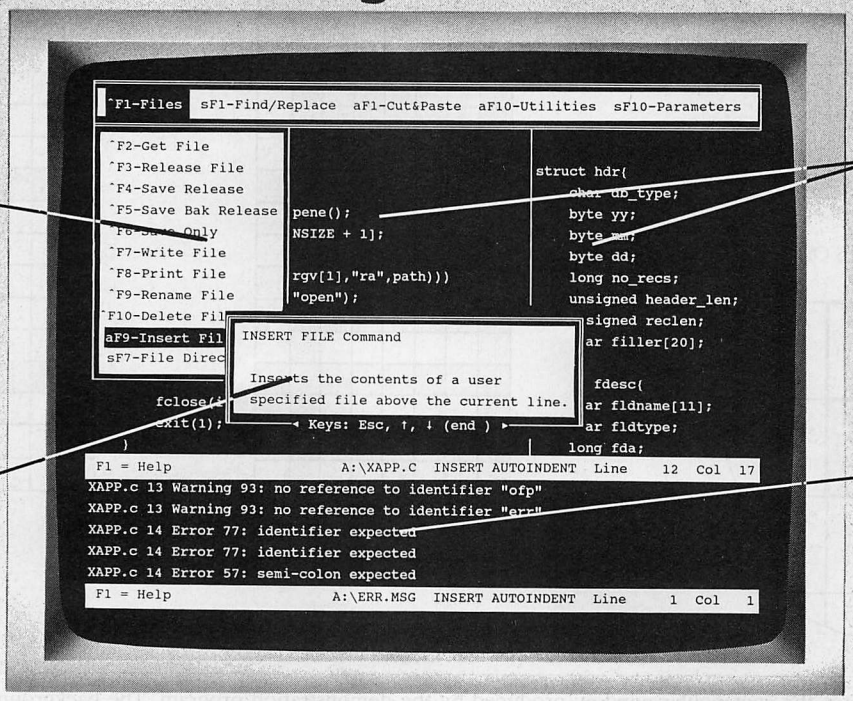
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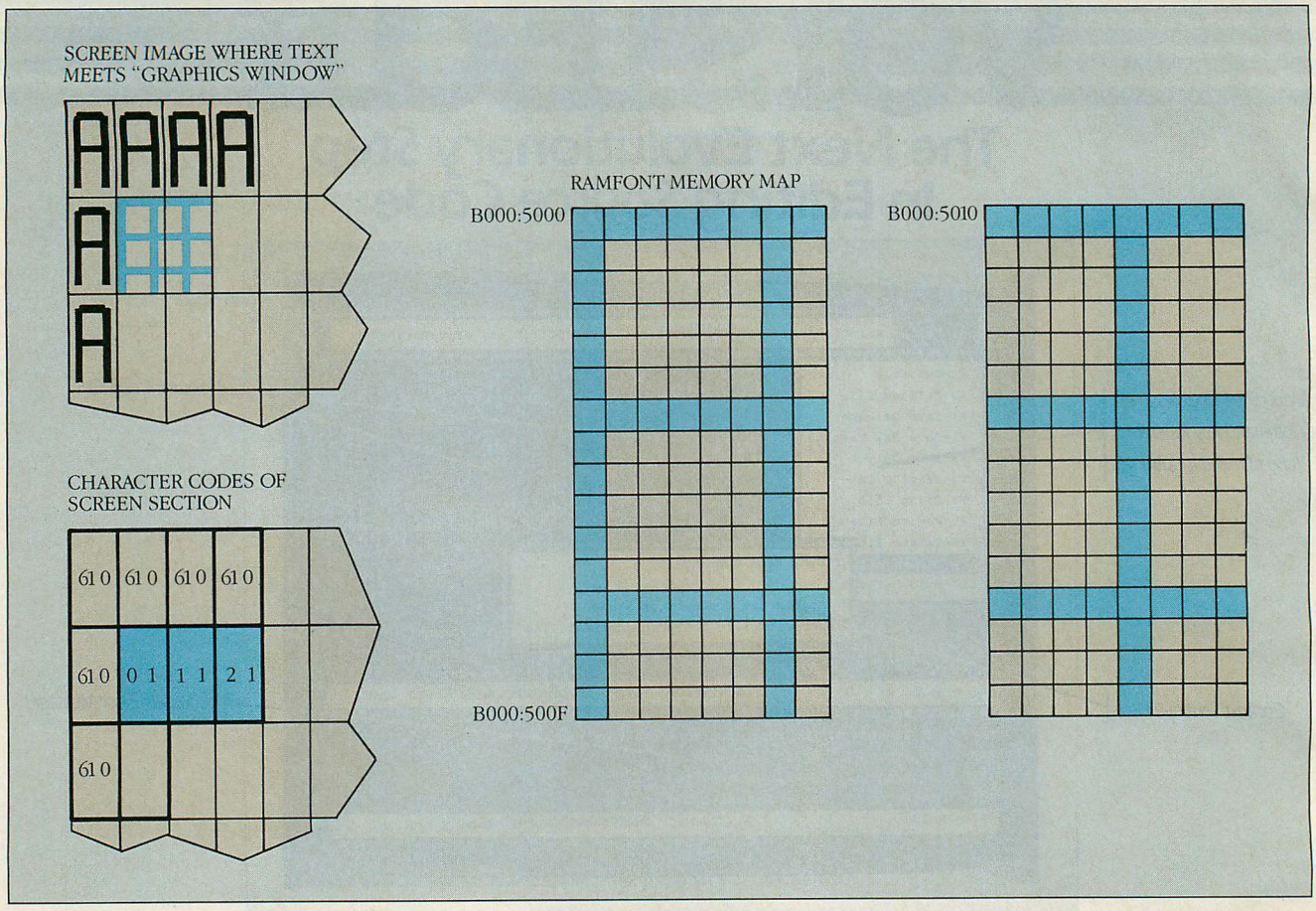
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FIGURE 2: *APA Graphics in a Text Screen*



This figure demonstrates the rectangular window produced by the demonstration program. The background is text, and the inset window contains graphics created by using the RamFont graphics mode.

is really generated by manipulating the font definition, putting the graphics data into a character form that is unique to one character on the screen.

Accessing any pixel on the screen in a soft font text mode requires a unique character code and font identifier for every character cell on the screen. Changing a pixel in the soft font that uniquely defines this character cell corresponds to directly changing the pixel on the screen.

Figure 2 illustrates the trick behind creating this mode—the graphics pattern illustrated is similar to that of the demonstration program (see photo 3). The dimensions and location of the graphics "window" is chosen, and each character "cell" in the window is given a unique character code and assigned to one font. Assigning these codes from left to right and top to bottom simplifies the logic when painting any pixel. The low four bits of the attribute bytes for these cells point to the font.

The program HERCDEMO, written in C (listing 1) and assembly language, demonstrates how this mode can be created and used. Listing 2, INIT.ASM, lists the assembly language code for the low-level routines required to manipulate the board's registers. HERCDEMO displays a single monochrome text screen that has a graphics image in a window. This is done by manipulating the soft fonts, putting a graphics image into the font area, then displaying the particular characters that contain the graphics image. The demonstration program is designed to work on the monochrome graphics card. It will run in monochrome mode on the InColor card; in order to get color, the attributes need to be modified and the colors selected for the graphics portion of the screen. The program HERCDEMO.EXE is generated from compiling and linking HERCDEMO.C and INIT.ASM. (The compiler used was Microsoft C version 4.0.)

The first routine in the program, InitializeHercules, sets up the pointers to the display buffer and the font space. Next, it spawns a process to the Hercules-supplied program RAMFONT.COM in order to load a font into the first font slot. RAMFONT.COM is used to load the fonts, including the font named 8X14.FNT, and to perform the mode setting. After setting the mode, RAMFONT.COM calls RamFont48, which is an assembly language routine in the file INIT.ASM.

Hercules recommends that all programming of the CRTC registers be done as quickly as possible, preferably in assembly language. The company supplies INIT.ASM on diskettes that come with the board. This program is intended to be modified by developers for incorporation into programs that use the board. INIT.ASM was modified to program the RamFont-specific I/O registers. RamFont48 was modified from INIT.ASM and programs the CRTC for RamFont 48KB mode. RamFont48 also sets the font to eight bits wide in the xModeReg, which suppresses ninth-dot replication. After the flow of control returns to InitializeHercules, the font area for the graphics window is set to zeros, thereby blanking it. Finally, a character string is loaded into the display page. The routine WriteCell

demonstrates how to place characters into the video display.

As a next step, the MakeWindow routine creates the window in the middle of the screen. The routine places a unique character and font code from left to right into each "cell" of the window until the rectangle is filled in.

After the window is set up, the graphics routine in DrawInWindow fills the rectangle with a grid every six pixels. Horizontal and vertical lines are drawn a pixel at a time by the routines DrawHorizontalLine and DrawVerticalLine. Both of these routines use the routine XORDot, which takes as an argument the *X* and *Y* pixel coordinates from the upper left-hand corner of the window and XORs the dot at the specified location. XORDot first of all calculates the bit within the pixel byte for the *X* direction, using the *X* coordinate modulo 8 (eight pixels per byte). The *Y* offset within the cell is the *Y* coordinate modulo 14 (that is, the number of raster lines that comprise a glyph in this particular font).

The actual character cell is determined by the *Y* coordinate, divided by the number of rasters per character cell (14) and multiplied by the count of cells per row. This value is the offset of the particular row's character cells for the window in the font. The actual character cell within that row is the *X* coordinate divided by 8 (again, with 8 pixels per byte) and multiplied by 16 (the size of the font space for each character cell—even though the font is only 14 rasters high, the board reserves 16 rasters for it). This is the actual raster to be manipulated. The bit within the raster, chosen above, is XORed.

After the program has executed, it resets the board into RamFont 4KB mode by spawning to RAMFONT.COM. Because the RAM that stores the font data is separate from the display RAM, this mode is still efficient if the contents of the "graphics window" will be changed continually.

The package. Hercules packages both of these boards with two diskettes containing drivers for Microsoft Word and Windows, Lotus 1-2-3 and Symphony, and Ashton-Tate's Framework. Other software supplied includes a font editor (FONTMAN) and a mode setting and locking software. In addition, the font disk includes several fonts. The font manager software will produce custom font files that can be loaded into the adapter as required.

Each card has one parallel printer port, largely because the MDA has one. The presence of the parallel printer port does not imply any awareness on the part of the adapter to the presence of the soft fonts for the purpose of printing the characters as they are represented on the screen. It is the responsibility of the user program to provide printer interfaces. The boards have no jumpers: that is, all configuration is controlled by software.

The documentation describes the programming interfaces thoroughly. Several code fragments are included for a complete explanation of the operation of both boards.

IN THE RIGHT DIRECTION

The Graphics Card Plus is most definitely a step forward in the process of improving the overall performance and versatility of the monochrome display. The additional fonts and the capability of this package to include graphics in text mode are new and useful features. Software developers are beginning to incorporate the card into their products. For a purely monochrome system, the Hercules Graphics Card Plus is the only card to own.

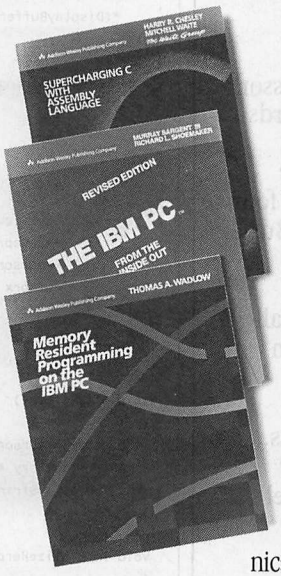
The InColor card offers users their first real choice apart from the EGA in medium-resolution color graphics. Despite the lack of a BIOS, the Hercules InColor card is truly an acceptable alternative to the EGA. Its acceptability is further enhanced by the fact that InColor software drivers have been written for most major applications.

The InColor card is not an EGA, however, despite the fact that it duplicates the EGA's functions. Another disadvantage of the board is that it is sole-sourced. The gain that is witnessed from having more than one font available is heartening; however, if it is accompanied by such stringent limitations on the character size, the advantages may be hardly noticeable. Only an outstanding sales success will guarantee that future support for the InColor card will be available from Hercules and other software developers.

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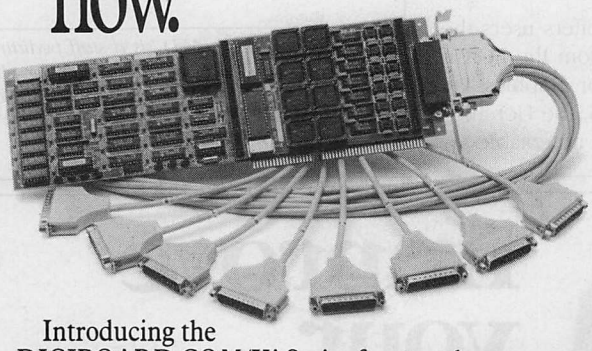
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LISTING 1: HERCDEMO.C

```
/* HERCDEMO.C -- A demo program of the Hercules RamFont Board.
   This program places the board into 48K RamFont Mode, and
   writes text into the display buffer. Next it will create a
   graphics window in the middle of the text.

         John T. Cockerham, M.D.  April 1987.
*/
#include <stdlib.h>
#include <stdio.h>
#include <process.h>
#include <conio.h>
#include <string.h>
#include <dos.h>
       /* Hard wired definitions of the graphics rectangle */
#define  WinStartX     10
#define  WinStartY     5
#define  WinEndX       30
#define  WinEndY       14
#define  WinRowLen     (WinEndX-WinStartX)
#define  GraphicXSize  (WinEndX-WinStartX)*8
#define  GraphicYSize  (WinEndY-WinStartY)*14
#define  ScreenRows    24
#define  ColsPerRow    80
#define  FontSpecifier 0x0001
#define  GridSize      6
       /* Basic definitions and global variables  */
 char far * DisplayBuffer;
 char far * FontBuffer;
 char far * WindowFont;
 char Pixels [] = {0x80, 0x40, 0x20, 0x10, 0x08, 0x04, 0x02, 0x01};
 int  cursorx, cursory;
 extern int errno;

 void RamFont48(void);  /* External Assembly routine for HGC */

 void WriteCell(x, y, c, attribute)
 int x, y, c, attribute;
 {
    int cp;

    /* Even though we are operating in 8 bit font mode,
       there are 80 columns on the screen */
    cp = (y * ColsPerRow + x) * 2;
    *(DisplayBuffer + cp)     = c;
    *(DisplayBuffer + cp + 1) = attribute;
 }

 void DisplayString(c)
 char * c;
 {
    int i;

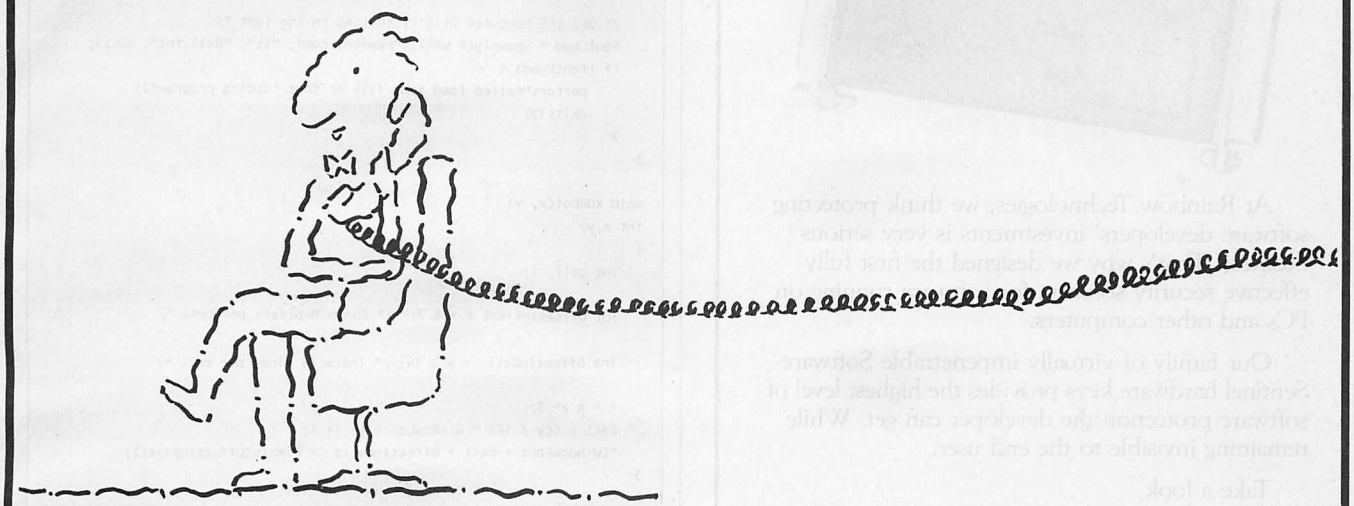
    for (i = 0; (i < strlen(c)) && (cursory <= ScreenRows); i++){
       WriteCell(cursorx, cursory, *(c + i), 0);
       if (++cursorx >= ColsPerRow) {
          ++cursory;
          cursorx = 0;
       }
    }
 }

 void FillBuffer()
 {
    cursorx = cursory = 0;
    while (cursory < ScreenRows)
       DisplayString("PC Tech Journal Hercules RamFont Test ");
 }

 void InitializeHercules()
 {
    int FontLoad, i;

    FP_SEG(DisplayBuffer) = 0xb000;  FP_OFF(DisplayBuffer) = 0;
    FP_SEG(FontBuffer)  = 0xb400;    FP_OFF(FontBuffer)  = 0;
    FP_SEG(WindowFont)  = 0xb400;    FP_OFF(WindowFont)  = 0x1000;

    /* Use the Hercules utility to load in the font */
    FontLoad = spawnlp(P_WAIT, "ramfont.com", "\\", "8x14.fnt", NULL);
```



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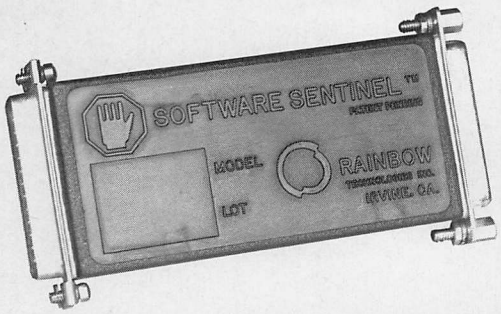
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```
    if (FontLoad) {
        perror("Failed load font file or font loading program");
        exit(1);
    }
    RamFont48();
    /* Clear out the graphics area for the window */
    for (i = 0x1000; i < 0x2000; i++)  *(FontBuffer + i) = 0;
    FillBuffer();
}

void ResetHercules()
{
    int FontLoad;

    /* Use the Hercules utility to load in the font */
    FontLoad = spawnlp(P_WAIT, "ramfont.com", "\\", "8x14.fnt", NULL);
    if (FontLoad) {
        perror("Failed load font file or font loading program");
        exit(1);
    }
}

void XORDot(x, y)
int x,y;
{
    int cell, t;

    int OffsetInPixel = x & 7;  /* There 8 pixels per byte */

    int OffsetInCell  = y % 14; /* There 14 lines per cell */

    t = x >> 3;
    cell = ((y / 14) * WinRowLen + t) << 4;
    *(WindowFont + cell + OffsetInCell) ^= Pixels[OffsetInPixel];
}

void MakeWindow()
{
    int row, column, cell;

    /* Fill in the rectangle in the active display buffer with
       sequential numbered characters AND a different attribute
       specifying the second character set */
    cell = 0;
    for (row = WinStartY; row < WinEndY; row++) {
        for (column = WinStartX; column < WinEndX; column++) {
            WriteCell(column, row, cell, FontSpecifier);
            cell++;
        }
    }

}

void DrawVerticalLine(x, y1, y2)
int x, y1, y2;
{
    int i;
    for (i = y1; i <= y2; i++)
        XORDot(x, i);
}

void  DrawHorizontalLine(x1, x2, y)
int x1, x2, y;
{
    int i;
    for (i = x1; i <= x2; i++)
        XORDot(i, y);
}

void DrawInWindow()
{
    /* Draw a grid in the window every so many units both x and y */
    int x, y;

    for (x = 0; x < GraphicXSize; x += GridSize)
      DrawVerticalLine(x, 0, GraphicYSize - 1);
    for (y = 0; y < GraphicYSize; y += GridSize)
      DrawHorizontalLine(0, GraphicXSize - 1, y);
}
```

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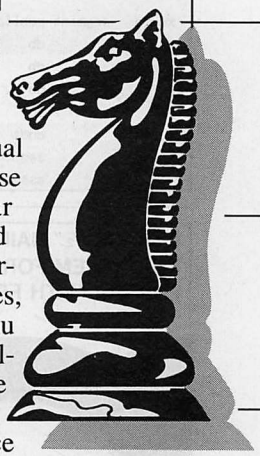


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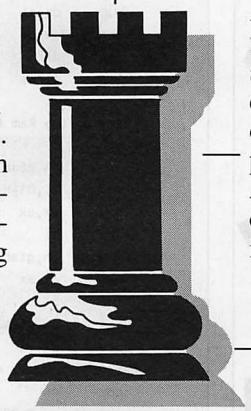
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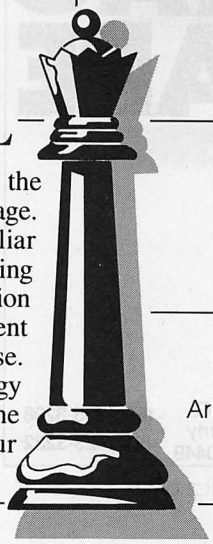
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```
int main()
{

   InitializeHercules();
   MakeWindow();
   DrawInWindow();
   getch();
   ResetHercules();
   return 0;
}
```

LISTING 2: INIT.ASM

```
;  INIT.ASM - This code illustrates the recommended technique
;             for changing modes (text or graphics) on the Hercules Graphics
;             Card.
;
;                Modified from Hercules Computer Technology
;                John T. Cockerham, M.D., April 1987.
;
;       port address
index           equ             03b4h
cntrl           equ             03b8h
;       control codes
scrn_on         equ             8
grph            equ             2
text            equ             20h

                public  _RamFont48

xdata   segment public 'data'
crttable        db      97, 80, 82, 15, 25, 6, 25, 25, 2, 13, 0, 0
gtab1           db      7               ; Turn on Ram Font 48K Mode
                db      13              ; Underscore on line 13
                db      7               ; Strike out Location
xdata           ends
xcode           segment public 'code'
                assume cs:xcode,ds:xdata
;
;       Set up RamFont Mode for 48K
;

_RamFont48 proc far
        push    es              ;Save Segment Registers
        push    ds
        mov     ax,xdata        ;Get out data segment
        mov     ds,ax
        mov     al,text         ;We operate in Text Mode
        lea     si,crttable
        mov     cx,2000h        ;Clear first 2000h chars of buffer
        mov     bx,0            ;Attribute for those 2000h chars
        call    setmd           ;Let the mode setting routine go
        pop     ds
        pop     es
        ret
_RamFont48      endp

setmd   proc    near
;
;     sets mode depending on al
;     si = parameter table
;     cx = number of words to be cleared
;     bx = blank value
        push    ds              ;save a few register
        push    es
        push    ax
        push    bx
        push    cx
;     change mode but without scrn_on
        mov     dx,cntrl
        out     dx,al
;     intialize the 6845
        mov     dx,index
        mov     cx,12           ;12 parameters to be output
        xor     ah,ah           ;starting from reg. 0
parms:  mov     al,ah
        out     dx,al           ;output register number
        cld
        inc     dx
        lodsb
        out     dx,al           ;output data
        inc     ah              ;next value
        dec     dx
        loop    parms
;
;       Set up the Ram font mode
;
        mov     ah,gtab1[0]     ;get the first element
        mov     al,014H         ;xmode reg at 14h
        out     dx,ax           ;first IO
        inc     al
        mov     ah,gtab1[1]     ;Underscore register
        out     dx,ax
        inc     al
        mov     ah,gtab1[2]     ;Strikeout value
        out     dx,ax
;     ram font mode is now on. Clear the buffer
        pop     cx              ;clear the buffer
        mov     ax,0b000h
        mov     es,ax
        xor     di,di
        pop     ax
        rep     stosw
;     scrn_on, page 0
        mov     dx,cntrl
        pop     ax
        add     al,scrn_on
        out     dx,al
        pop     es
        pop     ds
        ret
setmd   endp

xcode   ends

        end
```


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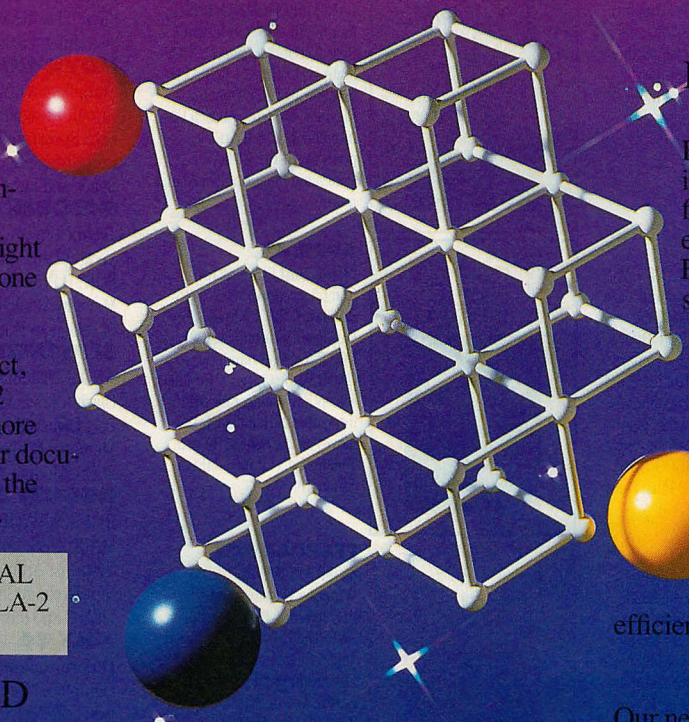
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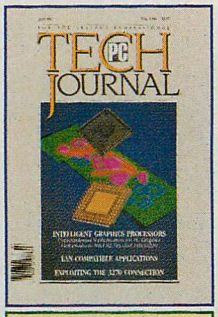
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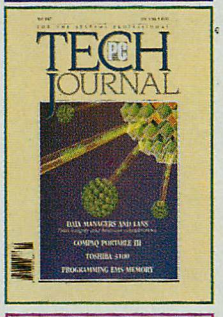
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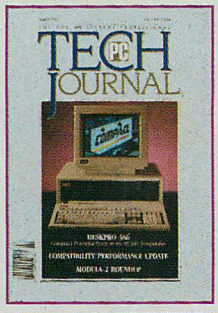
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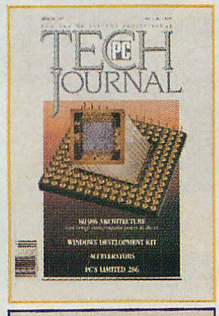
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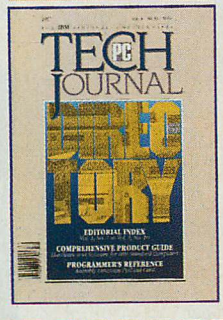
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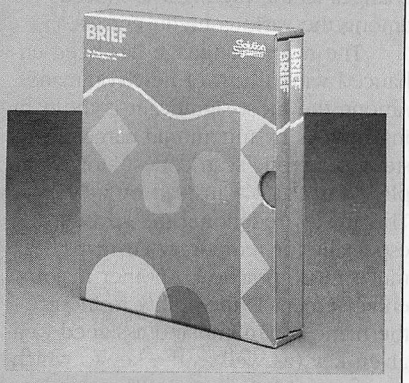


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The advanced features incorporated in version 2.0 of BRIEF (Basic Reconfigurable Interactive Editing Facility) are significant, turning BRIEF from an excellent editor into a truly outstanding one. Five months ago, *PC Tech Journal* reviewed BRIEF version 1.33 along with seven other editors in "Editors as Programming Tools" (Mark L. Van Name and William B. Catchings, May 1987, p. 160). Because version 2.0 makes significant improvements to both the editor and underlying command language, BRIEF deserves a second look.

Written by UnderWare, Inc. of Boston and published by Solution Systems, BRIEF is really two products in one. First, it is a powerful and intuitive program editor, and second, it is a special-purpose semicompiled language for creating an editor to the user's specifications. Both aspects offer features that make BRIEF unique among program editors. To an impressive list of features that are already present, version 2.0 adds an automated installation procedure, greater flexibility in entering commands in command mode, enhancements to the regular expression capability for searches, many new primitive commands in the macro language, and significant improvements in the speed of searching and file I/O.

High on the list of the editor's distinguishing features is an Undo capability that goes much beyond the mere Undelete offered by most other editors. Any operation—except disk I/O, window operations, and Undo itself—can be undone. The depth of the Undo stack can be set to as many as 300 operations. This capability offers much more than insurance against mistakes; experienced users soon learn to use it as a navigational feature. For example, after journeying into the depths of a file with the Search command, the user may invoke Undo to quickly return the cursor to the original point.

BRIEF's second strength is a macro language that offers much more than merely remapping the keyboard and performing command sequences with a single command or keystroke. It can be used to extend the editor's features or fundamentally alter its look and feel. Although it uses an unnatural (to anyone but LISP programmers) prefix notation, the language will be familiar to any C programmer. All of the editor's basic capabilities are invoked with function names that can be collected into named macros, becoming keywords in the macro language. The integration of these user-defined functions into the editor's environment is so complete that the entire sequence of commands performed by a macro can be undone by a single Undo command. From the user's perspective, no difference exists between a predefined primitive operation and a complex programmed one. Either kind of command may be assigned to any key to construct a key-driven command structure to the user's specification. Users without a bias towards a specific command set will find the default key mapping function to be quite adequate.

The changes introduced in version 2.0 become apparent from the moment of installation. A new interactive installation program creates subdirectories, copies files, and inserts SET statements into the AUTOEXEC.BAT file to establish the environment variables used by BRIEF. Although new users will find this procedure convenient and painless, experienced users might be uncomfortable with anything so automatic and would appreciate directions on performing the installation manually in order to customize it. As it is, the best way to produce a modified installation is to run the SETUP program and then to edit the AUTOEXEC.BAT file and move files between subdirectories. The next version, scheduled for release by the time this reaches print, is supposed to address these issues.

The start-up sequence has been changed significantly from version 1.33, so users with highly customized start-up macros will need to perform some conversion. The macro language is compatible, so the conversion involves no recoding, only grouping the user's macros into different files. The user is encouraged to keep all customization code out of the standard start-up files, simplifying the update procedure for subsequent versions.

Changes to the editor include support for three types of marked blocks: "snaking" character blocks, whole-line blocks, and columnar blocks. Previous versions supported only the first type, but the others could be implemented with some fairly complicated programming in the macro language.

Two time-saving enhancements of BRIEF 2.0 concern the treatment of the command line, which is used for entering commands not assigned to keystrokes and for parameters of commands. First, the command line now

accepts a command name along with its parameters; previous versions ignored any text following the command name and always prompted for the parameters. Second, commands that display a default or previous entry now allow that entry to be edited rather than just accepted as displayed or having to be totally reentered.

One of BRIEF's strong points is a fairly complete implementation of regular expressions, which is used to perform sophisticated wild-card text searches. In this release, the changes made in this area are equally divided into two improvements and two regressions. Of the improvements, a new-line character (\n) can be placed anywhere within a regular expression, not just at the end, allowing matches over line boundaries. A new repetition operator (+), matching one or more occurrences of a set of characters, has been added to the @ operator that matches zero or more occurrences.

However, an idiosyncracy has been introduced into the implementation of the repetition operators: a subexpression followed by a repetition operator matches the minimum number of occurrences of that subexpression, not the maximum number as was the case in version 1.33 and as is standard in UNIX editors (where the concept of regular expressions originated). When a regular expression ends with a repetition operator, only a single occurrence of the repeated subexpression is matched. This makes it awkward, for example, to replace a string followed by an unknown number of spaces.

The other change is in the use of the symbol for matching a previously found set of characters; the symbol now can be used only in the replacement part of a search-and-replace operation. For example, writing a regular expression to find doubled words is no longer possible. The removal of this seldom-used construct is a reasonable trade-off for the gain in search speed.

Since BRIEF is a programmer's editor, it offers a host of features for programming support. The lowest level, available for any type of file, is automatic indenting. Higher levels, including keyword expansion and syntax-driven template creation, are provided for the C language only, but may be added for others by programming in the BRIEF macro language. The levels of indentation and syntax support are determined by environment variables when BRIEF is loaded, and cannot be changed once within the editor.

The compiler interface consists of a *compile* command that executes a language processor from within the editor, passing it the name of the file being edited; the name of the compiler and its command-line parameters are set for a particular filename extension by means of DOS environment variables. The editor comes with macros to perform error tracking for the BRIEF Macro Compiler, the Microsoft Macro Assembler version 4.0, and C compilers from Computer Innovations, Lattice, Microsoft, and Wizard. Compiler error messages are redirected to a file, and when the compiler exits, the editor displays each message in turn, placing the cursor on the offending line in the source code. Again, support for other language processors may be added by the user. All of this support is implemented in the BRIEF macro language, and the source code is provided, so the user has a guide to extending it to other languages and compilers.

In addition to programming support, a macro source code is provided for several other features that extend the editor's utility. One set of macros implements simple word-processing functions, such as centering text and reflowing paragraphs between specified margins. Another provides basic functions for implementing both pop-up windows and point-and-shoot menus. This set of macros can be used to produce a fundamentally different user interface, such as Lotus-style horizontal menus, complete with a help text that changes as the highlight is moved among the various menu entries.

The macro language has been enhanced with a host of new commands. Among the most significant is the naming of keys by mnemonic names instead of cryptic scan codes—for example <Ctrl-PgUp> instead of #-31744. This makes redefining the keyboard, especially for temporary keymaps, much more practical. Another major enhancement is the ability to inquire the name of a command assigned to a given key (as well as the key to which a command is assigned). The BRIEF Help facility uses this enhanced ability to good effect; the help tables do not need to be modified every time the user reassigns a command.

: • 80x86 • 680x0 • VAX • RT PC • 370 • 320xx • 80x86 • 680x0 • VAX • RT PC • 370 • 320xx • 80x86 • 680x0 • VAX • RT PC • 370 • 320xx • 80x86 • 370 • ..... Writeln("An investment in Professional Pascal is one well made."); .....

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In addition, each of the editor enhancements is supported by a corresponding enhancement to the macro language. For example, the command to begin a marked block takes a parameter that indicates the type of block (character, line, or column), and the function testing the existence of a marked block returns the block type.

Performance has been enhanced in the areas where BRIEF was weakest: file I/O. The time to write a file has been cut in half, and merge time is ten times faster (see the May review). Searching has been speeded up by 30 to 100 percent, depending on complexity. Overall, BRIEF is now in the mainstream of editor performance for most operations, whereas the previous version fell in the slow end of the range.

The documentation has been redone completely and now consists of two spiral-bound manuals titled *User's Manual* and *Macro Language Guide*. The contents are several orders of magnitude better than that of the previous version, and are easily better than any program editors reviewed in May. Both new and experienced users should be satisfied, with the exception of the previously mentioned effects of the automatic SETUP program.

As good as BRIEF is, there are several reservations. The first is the aforementioned nonstandard usage of repetition operators. Another is the need to compile every macro before it is executed. This is fine for macros that are meant to be saved and used repeatedly, but a bother for quick ad hoc command sequences. There is a facility for recording and playing back keystroke sequences, but it is severely limited by remembering only one sequence at a time. Finally, in certain operations, BRIEF is no speed demon. This is especially apparent in the operations implemented with highly nested macro calls, such as creating windows and interpreting menu operations. These problems are tolerable on an 8-MHz AT, but unbearable on anything slower.

Still, for the majority of program-editing operations, BRIEF 2.0's performance is more than adequate; and its power is second to none. This more than makes up for any hesitation in less-frequent operations. This latest incarnation of BRIEF, even straight out of the box, is high on any list of contenders for the title of best programmer's editor. With some reprogramming, it can be made to approach any programmer's idea of the perfect editor.

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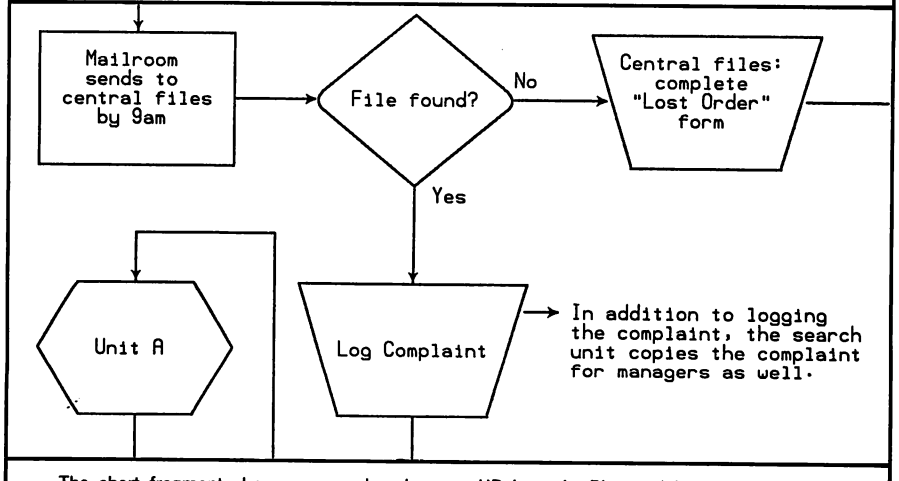
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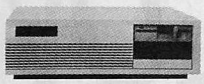
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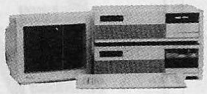
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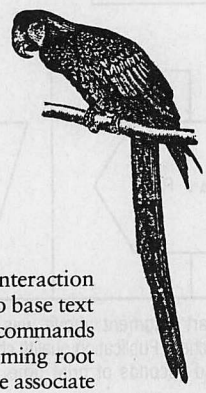
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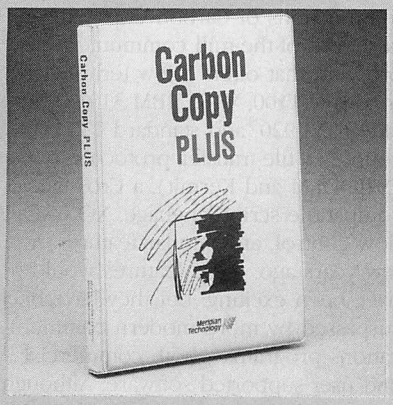
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One of the oldest and best known remote-programming packages, Meridian Technology's Carbon Copy, has been enhanced significantly. Carbon Copy PLUS improves the software and adds an independent communications program (the PLUS) to the package. (For reviews of four remote computing products, see "Controlling from Afar," Augie Hansen, April 1986, p. 84, and "PCANYWHERE," Product Watch, Chris Dunford, June 1987, p. 189).

In addition to its new terminal emulator, major improvements in Carbon Copy PLUS include support for additional modems (55 are listed in the installation screen); a graphics-transmission capability, including Hercules graphics; and support for additional communication ports (COM3 and COM4). The new package is compatible with older versions in that a remote computing session can run between it and any of the earlier versions.

Before using Carbon Copy PLUS, two copies—one for each machine—must be installed. This involves setting the registered users' names (which cannot be changed once registered) and specifying modem types, baud rates, and the like. The installation program also is used to set up password tables and dialing directories, and can be rerun to update these data.

After installation, the distribution diskettes contain all software needed to run the system, notably CC.EXE (the host program) and CCHELP.EXE (the remote program). All of the files can be copied to hard disk and to back-up diskettes as desired because Carbon Copy PLUS is not copy protected.

To use the system, CC.EXE is run on the host PC; and CCHELP.EXE, on the remote machine. Either can be accessed by menu from a small shell program, CCSTART. CC.EXE initializes the host's modem, exits back to the DOS prompt, and remains in memory, awaiting a telephone call. Between calls, the host PC can be used normally.

CCHELP (on the remote machine) is not a memory-resident program; when run, it presents a menu that permits some minimal configuration options and allows the remote to dial the host—or vice versa.

To dial, the CCHELP user types in a telephone number or selects a name from the dialing directory. After a connection is made and the password is accepted, the CCHELP screen disappears and is replaced by an image of the host's screen. At this point, the remote's keyboard and screen are "attached" to the host, and the remote user can run any commands or programs available on the host PC. Because the host's keyboard is also enabled, either keyboard can be used to run host programs. If desired, the host keyboard can be disabled.

The operator of either machine can interrupt the session with a hot key (Alt-Shift). Through control screens with small dialogue windows, the operators can confer on procedures. The control screen also has a printer control and an option to switch the phone link from data to voice or back. From this screen, F1 terminates the session (disconnecting the two machines); and F10 returns to the regular session, with original screens intact.

Carbon Copy PLUS also provides various ancillary functions that support remote computing. For example, several options are available that control where printed output is sent; and a screen-capture facility lets users record and review complete screens of data. Of particular interest is the CCDOS facility, which permits the remote user to transfer complete files between the two machines, and to execute other DOS-like commands on either machine.

The file-transfer facility is nicely implemented. To transfer the file MYFILE.TXT from host drive A to remote drive C, the user merely types

```
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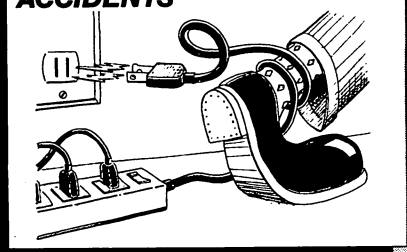
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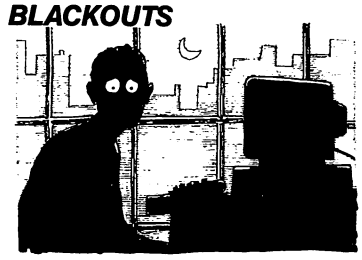
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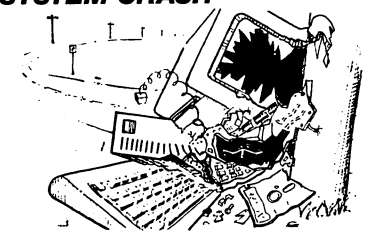
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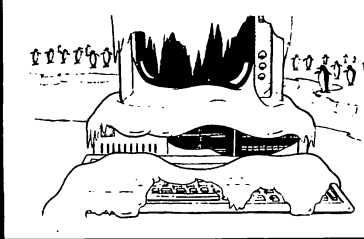
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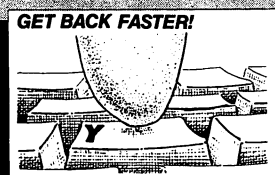
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prefixed by H for host or L for local; thus, HA: refers to host-drive A, and LC: refers to local-drive C (remote). The structure is simple and elegant.

The PLUS part of the package is the terminal emulator, a stand-alone asynchronous communications program not directly related to the remote-computing functions of Carbon Copy. It is a fairly run-of-the-mill communications program that offers a few terminal modes (VT100, VT52, IBM 3101, Televideo TVI-920, and standard TTY), a couple of file-transfer protocols (XMODEM and Kermit), a Crosstalk-compatible script language, XON/XOFF flow control, and similar features. A few years ago, these features would have been exciting; but they have been surpassed by more modern communications programs—both commercial and user-supported software. Although a terminal emulator in the package is handy, this one would attract very little attention as a separate program in the current communications marketplace.

In testing Carbon Copy PLUS, several programs were run in various categories: spreadsheet (Paperback Software's VP-Planner), word processor (WordPerfect 4.2), integrated data manager (Symantec's Q&A), text editors, DOS commands (both internal and external), compilers, and assemblers. Although many of the programs were highly screen-oriented, Carbon Copy PLUS handled them quite adequately. It is clear that the Carbon Copy PLUS designers took care to minimize the amount of data that must be transmitted over the slow telephone link. For example, when WordPerfect scrolls the text, Carbon Copy PLUS instructs the remote PC to perform a local scroll and then transmits only the new top or bottom line. Clearly, this is much faster than retransmitting the entire screen.

Most memory-resident programs worked well on Carbon Copy PLUS. Borland's Sidekick, for example, behaved quite properly, and all its functions could be accessed. Carbon Copy PLUS, however, did have difficulties with some memory-resident software. A resident screen blanker did not operate correctly (the screen could not be restored easily from the remote); a datapath utility (providing a PATH-like facility for data files and overlays) caused CCINSTAL, the installation program, to crash; and Borland's Turbo Lightning, a spelling checker, worked well except that it beeped only on the host machine, rendering the realtime speller unusable on the remote.

Problems such as these are not necessarily representative of deficiencies in Carbon Copy PLUS, but rather may reflect incompatibilities. Turbo Lightning, for example, manipulates the host's speaker at the hardware level; Carbon Copy PLUS could hardly be expected to trap this behavior and transmit it. Such difficulties are mentioned only as a caution; the prospective buyer would be wise to check for compatibility with existing resident software before purchasing the package.

What is the final verdict on Carbon Copy PLUS? This reincarnation has a lot going for it, but its features are surpassed by those of a package recently reviewed—PCANYWHERE from Dynamic Microprocessor Associates. Of the two programs, the latter is much preferable. In the tests, Carbon Copy PLUS seemed more crash prone; the system locked up on numerous occasions.

The PCANYWHERE package has a nicer "feel" than does Carbon Copy PLUS. Screen updates are smoother, and the keyboard is much more responsive to the remote typist. Carbon Copy PLUS has an annoying delay before the remote user's keystrokes appear on his or her screen. Moreover, installing PCANYWHERE is easier; many of Carbon Copy PLUS's configuration options, including the password tables and dialing directories, are available only by rerunning the installation program.

In addition, the PCANYWHERE host program can be operated remotely by almost any terminal program (even by dumb terminals and non-IBM-compatible computers). Carbon Copy PLUS runs only between two PC compatibles running two copies of Carbon Copy. While Carbon Copy users must purchase two copies of the software, a single copy of PCANYWHERE can be used quite successfully (although one copy is needed for each host machine). In the tests, Carbon Copy PLUS also failed to request password verification when the host dialed the remote.

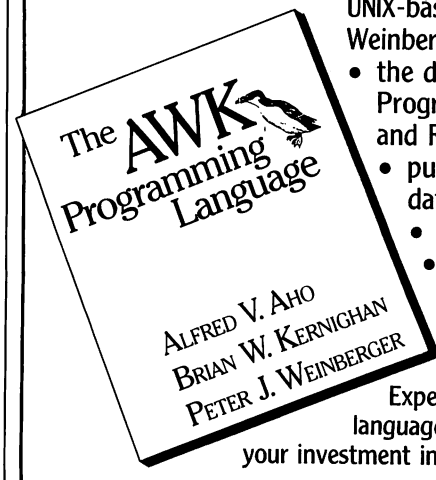
In other areas, Carbon Copy PLUS outshines PCANYWHERE. By insisting on two closely compatible machines, Carbon Copy is able to perform certain functions that PCANYWHERE cannot. For example, using an advanced-keyboard option, it can pass the exact status of the keyboard shift keys from the remote to the host; PCANYWHERE cannot always do this. As a result, some resident programs (such as Quarterdeck's DESQview) cannot be operated because hot keys do not work. Carbon Copy PLUS has fewer problems here.

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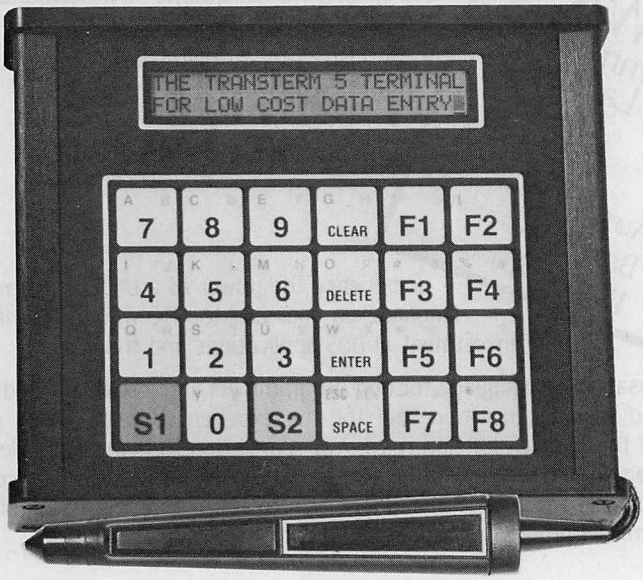


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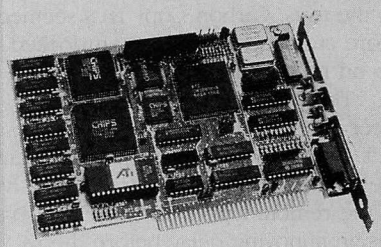
For the most part, however, either system can run most software. The user's choice, therefore, should be guided by such factors as ease of use, dependability, flexibility of operation, and cost effectiveness. On these scores, PCANYWHERE is the better alternative.

—CHRIS DUNFORD

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ATI Technologies has a novel entry in the enhanced graphics market with its EGA WONDER. This adapter offers only 640-by-350 pixel display resolution—and none higher—for all displays. It distinguishes itself from all other EGAs, however, by bringing EGA resolution to low-resolution color and composite-monochrome displays.

As might be expected, EGA WONDER also provides EGA mode support for IBM and compatible enhanced color and monochrome displays. EGA WONDER also can convert color to shades of gray for monochrome displays, including the Compaq PC portable (although the Compaq needs an optional board to install EGA WONDER).

EGA WONDER uses *interlacing* to display EGA resolution on low-resolution (200 lines) color and composite-monochrome displays. In interlacing, hardware alternates painting raster scan lines with each frame: The first frame has the even scan lines, and the second has the odd. The penalty, however, is an increased flicker on the screen.

To emulate IBM CGA and monochrome, EGA WONDER uses the nonmaskable interrupt (NMI). Most boards reviewed by *PC Tech Journal* use the

NMI for CGA and monochrome emulation; this board is no exception.

A hardware switch is used to set emulation. When it is not set, the board can be used only with software that supports the EGA, or with emulation software that runs in CGA or monochrome mode. When a user's program changes EGA WONDER's hardware registers, the adapter issues the NMI. The BIOS ROM intercepts the NMI, interpreting and effecting the program's intentions. Thus, mode-switching software usually is not needed (except for some PC compatibles).

This approach, however, is somewhat fragile in all NMI handlers, including 8087 math coprocessors, because only software that shares the NMIs will function correctly. Although software should be written to allow sharing, this is not always the case; 8087 interrupt handlers are common culprits. If any program does not share the NMIs (and a number of copy-protected software products do not), then emulation will not work.

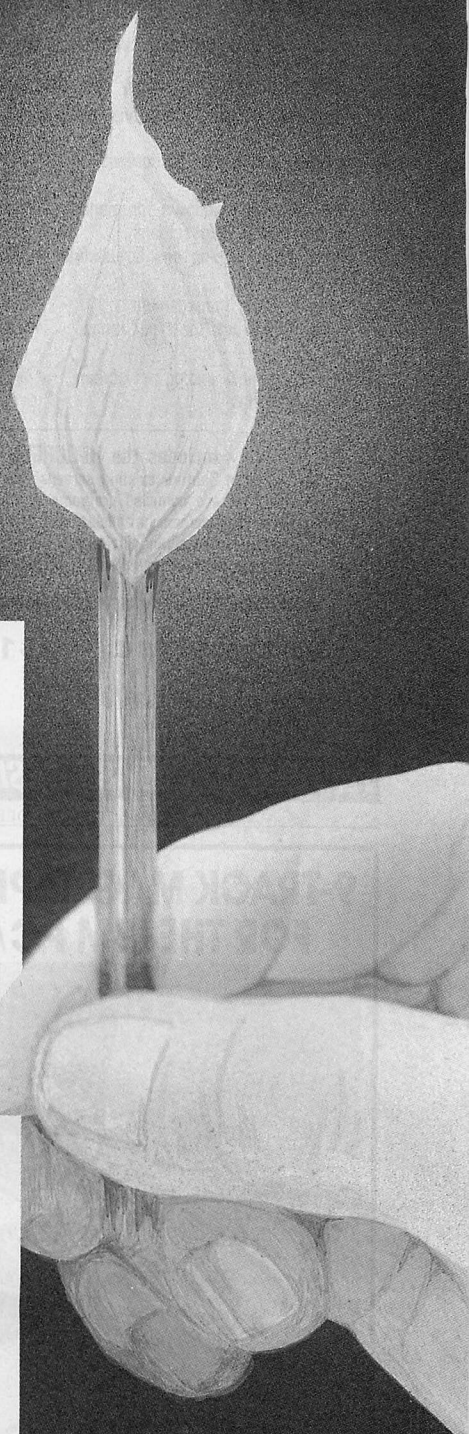
The adapter is fairly easy to install. A bank of eight DIP switches specifies to the BIOS the boot-up mode, the monitor type (RGB, EGA, or monochrome), and emulation features.

EGA WONDER comes with a complete set of drivers for Lotus 1-2-3, providing 132-column modes for 1-2-3 and MicroPro's WordStar. A mode-setting, screen-saving program, SMS, and a diagnostic program are on an enclosed diskette.The package has no drivers for Microsoft Windows; none is needed because the standard EGA drivers supplied with Windows can be used. With a color-graphics or composite-monochrome display, the user configures Windows as operating with an EGA. The adapter provides EGA resolution by interlacing the display.

The product was tested with the standard set of EGA-testing software, including *PC Tech Journal*'s EGATEST; EGA Paint by RIX SoftWorks; Fantasy-Land (IBM's EGA demonstration program); WordPerfect Corporation's Program Editor; Microsoft Corporation's Word and Windows; FANSI-CONSOLE, from Hersey Micro Consulting, Inc.; and the Computer Graphics Interface, from Graphic Software Systems. The tests were run on an IBM PC with 640KB RAM, a 8087 math coprocessor, and dual displays (NEC's MultiSync and the IBM monochrome display). (For a review of EGATEST and compatibility issues, see "Multiple Fonts," John Cockerham, this issue, p. 168.)

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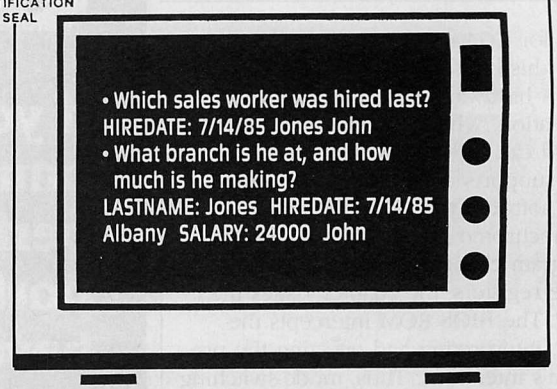
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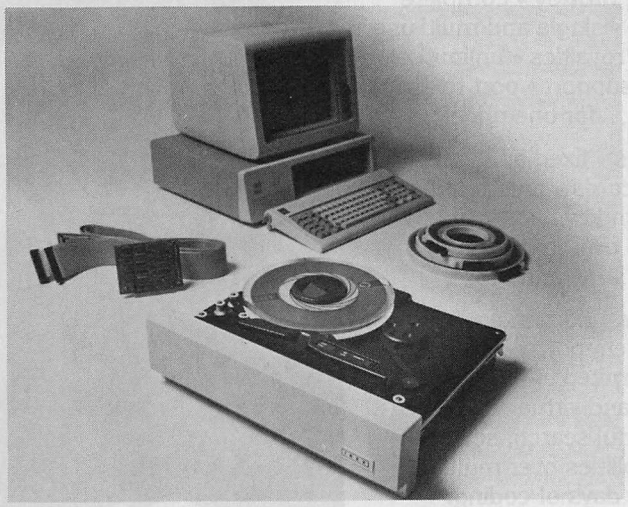
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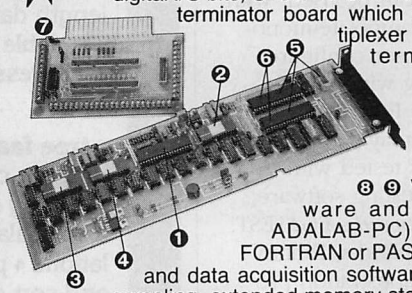
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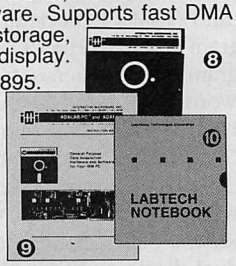
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EGA WONDER passed most of these tests—albeit, with rather laggard colors. With emulation active, certain actions of the adapter were painfully slow. Screen scrolls were twice as slow as other adapters. Operation was also slower than with the emulation turned off; smooth scrolling and split-screen raising and lowering were slower, and in Word, cursor movements were much slower. Turning off the emulation at boot-up had a salutary effect.

The emulation switch also affected the BIOS dot-plot timings from the benchmark EGATEST. In this test, the software paints 65,000 pixels in individual calls to the BIOS dot-plot routine. With emulation active, the adapter took 56.2 seconds; with emulation off, it took 47.2 seconds, which is slower than average for EGA-compatible boards. Other timings from EGATEST, direct I/O calls and subroutine calls, were identical to other EGAs using the Chips and Technologies' chip set.

The ATI BIOS tested was version 1.06. With the extra code of emulation, the chip is 32KB in size. The only notable bug was in the BIOS cursor-emulation routines: The BIOS left a thin line of a cursor on the screen during the operation of FantasyLand, and yet it had only a single line of a cursor during normal DOS operation.

The save area and interrupt 42H pass-through are both correct. During the test boot-up, however, the BIOS incorrectly stated that the math coprocessor was not present and warned that emulation may operate incorrectly, even though the emulation does not depend on a math coprocessor.

The emulation caused some problems with the operation of some Microsoft logo screens. The normal logo screen for Windows is an animated converging of the Microsoft corporate logo, done in EGA mode 6, 640-by-200 two-color graphics mode. With EGA WONDER's emulation active, the monitor was unable to synchronize the image, which rolled on the screen. With NMI emulation turned off (switch 8 on the adapter's switch block), the monitor was able to synchronize the logo screen. During painting of the logo screen with the TTL gray-scale emulation active, the image on the screen split in half. This arrangement of scan lines mimics exactly the video RAM layout for the CGA.

In the frenzied aftermarket of the EGA and the aftermath of the VGA, this adapter has probably found its corporate niche. By providing monochrome gray-scale emulation of color, EGA WONDER eliminates the principal cost objection to EGA upgrading—the need to buy a new monitor.

Despite the appeal of gray-scale monochrome and EGA resolution on a CGA display, EGA WONDER needs some touch-up work—the flicker of this adapter with composite and RGB monitors (non-EGA) is fatiguing. Even so, this is the EGA for most corporate PCs, whose work load is mostly text with occasional graphics. EGA WONDER allows the PC user to migrate slowly, recouping the investment in hardware.

—JOHN COCKERHAM

As this issue went to press, EGA WONDER had been enhanced to provide 800-by-560, 752-by-410, and 640-by-480 color graphics modes, as well as VGA modes 11 and 12 (640-by-480, 2 and 16 colors, respectively) on multisync monitors with no price increase. Also new: high-resolution software drivers for Windows, GEM AutoCAD, Lotus 1-2-3, and Lotus Symphony; and 132-column support for Lotus 1-2-3, Lotus Symphony, Wordstar, and WordPerfect.

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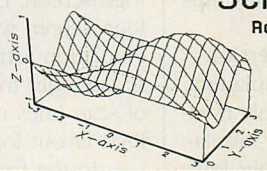
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A Good Answer

The lessons learned in applying technology to simple telephone answering machines are important to designers of computer hardware and software.

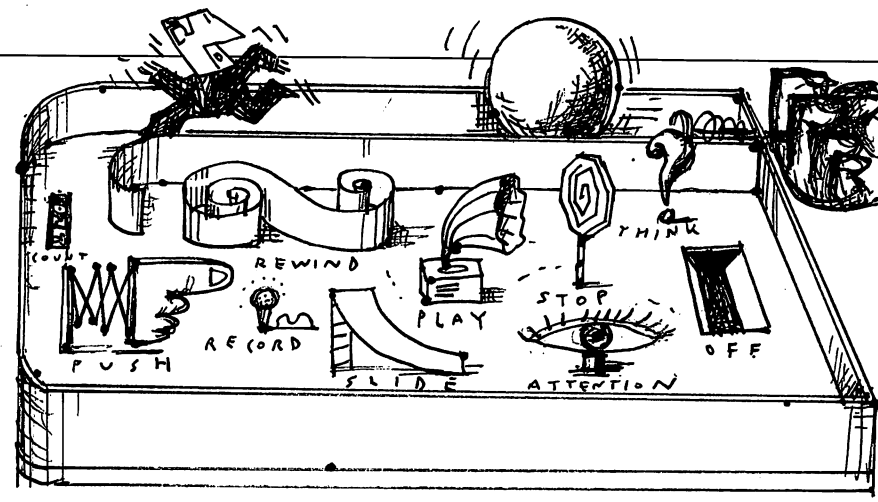


ILLUSTRATION • MACIEK ALBRECHT

Years ago I purchased a Sony dictating unit that had no manual. In all the years I have used this unit, I have always understood what every function was for and have never had any reason to wish for an operator's manual. It is, in some sense, an example of the ultimate in human factors—a machine so well engineered that its operation is self-explanatory. Designers of computer systems can learn from this.

Traditionally, the human factors of computer hardware have meant concern for the physical characteristics of a device. Typical human factors issues include, for example, the appropriate height of a chair or the intensity of illumination for normal vision. Others concern the pressure required to depress keys, the ability to change the angle of a screen, the size limits in selecting objects using a light pen, or the shape of a hand-held device.

But this is not all. Designers of equipment have considerable latitude about the many details of design:

- How big should the labels be?
- Should some labels be larger than others?
- What buttons should be on the front of the device rather than the back?
- How loud should a tone be?
- Which keys should be most visible?
- Where should the on/off button be?
- What buttons should have illuminated monitors?

Of course, such issues are brought up when things go wrong and people notice them to such a degree that a complaint is in order. But most users (and, I believe, many designers) miss the strategic importance of the myriad of little details that have to do with the design of physical devices.

To bring this matter to light, consider the now commonplace device mentioned at the outset, a telephone answering machine. Most of us are familiar with these machines—we either use them on a regular basis, have one of our own, or at the least have had occasion to record a message on such a machine. The specific machine is a recent purchase of mine—the AT&T Answering System 1310. All things considered, the machine is functionally excellent, and quite automatic. The basic keyboard is illustrated in the accompanying figure.

A first observation (see the figure) is that the device looks somewhat like a simple tape player. It has PLAY and STOP buttons, as well as buttons for FAST FORWARD, REWIND, and RECORD. All of this is innocent enough. A difficulty arises when in looking at the labels on the left side of the figure. Here, a single switch can sit in one of three positions. The labels are ANSWER, ANNOUNCE, and MESSAGES; moreover, these labels have been squeezed together. Under the labels, the switch must be moved to slightly different positions in order to set one of these three functions.

I suggest that this labeling represents a misconception about ordinary use of an answering device. The FAST FORWARD and REWIND features, so useful when recording and playing music or using a dictaphone, are not particularly useful functions for an answering machine. Most users, most of the time, simply listen to their message, then start again. Of course, on some occasions one might wish to fast forward (for example, playing a lengthy sequence of messages twice), but for normal home and light business use, I suggest that these occasions are rare. In fact, I submit that the most frequently used control is precisely the one with the smallest labels!

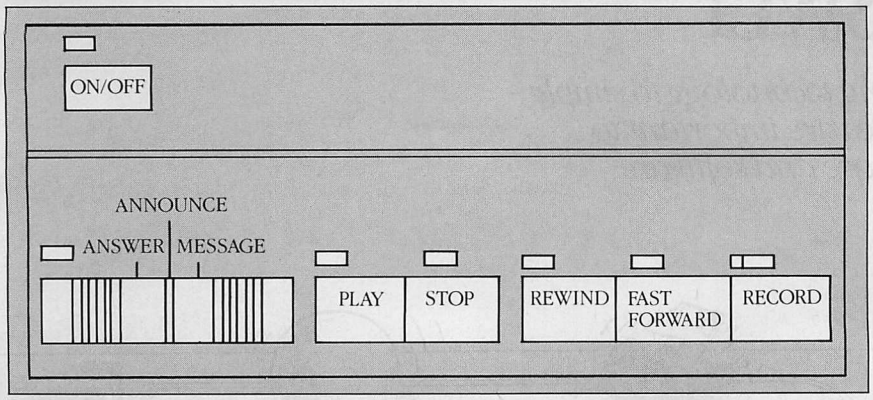
But this unit has an even more serious design flaw. Probably the most frequent action sequence for most users is the following:

1. A more or less standard announcement is preset by the user.
2. The telephone system is unattended for a period of time.
3. The user returns to find several messages.
4. The user plays each message.
5. The user returns the machine to its original state.

I ask the following question. After this sequence, what should the default be—save the existing messages, record new ones after these, or delete the existing messages, recording new messages over the old ones?

In the first case, the user must make an explicit action to delete existing messages. In the second case, the user must make an explicit action to preserve them. This choice, in turn, begs the next question: What key or

FIGURE: *Answering Machine Keyboard*



This keyboard resembles that of a tape recorder. However, the switch on the left side (bottom) is used for several important actions, which is not optimal.

key sequence is appropriate to delete or preserve the old messages?

For a telephone answering system, the above scenario is not an idle cursiosity. Key information is often left on my machine: the time of an arrival, a telephone number, an address, or some other piece of data. The message is important and contains important information. I need to hear it again, perhaps to write down the information. I have no backup once this is gone.

What does this say about my original question? Simply that the deletion of messages by default can be dangerous. Yet, this is precisely what the model 1310 does. This scenario has happened to me many times—I play a message, realize it is important, reset the machine, and the message is gone!

I, thus, would argue that deletion should not be the default. A switch to alter the default to deletion should not be the default. A switch to alter the default to deletion (or not) might be desirable. Then the user could establish his or her own default. Nevertheless, automatic deletion of anything, from telephone messages to computer files should be an action that the user must make explicitly. An explicit delete button or an explicit delete key sequence seems preferable.

For the existing model 1310 keyboard, no simple key sequence comes to mind. What the 1310 actually does is allow an override to automatic deletion in the following way: When the triple switch (ANSWER-ANNOUNCE-MESSAGES) is moved from MESSAGES to ANSWER, the user can hold down the STOP key while moving the switch. The STOP button must be held down until the ANSWER light goes on.

This sequence, I submit, is cryptic. If STOP is not pressed at the right time, messages are deleted. This sequence is error prone and difficult to explain. The result is either reluctance of someone to use the machine or fear of making a mistake, with resultant personal stress. The more important the message, the greater the stress.

This is not the end of the story. After several mishaps, I read the manual again and again, and finally found a way to replay messages that were apparantly deleted. It reminds me of the DELETE feature on the Macintosh, where a file is not actually deleted until the trash is emptied. So too for the model 1310. Another sequence involves the PLAY button, which, if held down continuously, will play what is on the tape regardless of previous instructions. Not a pleasant experience, considering the machine's annoying beep.

This kind of story, I think, represents a number of bottom line issues in human factors. Human factors is an attitude that places the user first. When we try to think about the user, understand his or her problems, and the kind of human situation in which a device or piece of software will be used, we can make better decisions.

Second, the goal of human factors is to make our lives a little better with machines. The goal is to reduce stress and make work easier—an attempt to harness technology in our service. It is not particularly about power and speed. It is about making things work better for humans.

Henry F. Ledgard, Ph.D., is a consultant specializing in software engineering audits, education, and human factors. He has written several books on programming style.

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210	PC-AT Board Level	I-BUS Systems	136
159	Compatibles	PC Direct	125
	MULTIFUNCTION/MEMORY CARDS		
179	Expansion Board	HiTech Materials	192
187	In Board 386	Intel Corp.	166 & 167
180	d Clock II	Micro Sync Inc.	160
	GRAPHICS SYSTEMS/CARDS		
206	EGA Wonder	ATI Technologies	143
242	Kontrast 7000 CB	Kontron	41
161	PG 1281	Matrox	74
227	Photon Graphics Boards	Personal Computer Graphics	22
223	Breakthru 286	Personal Computer Support	94
193	VIVA 2000, 20002, 1280	QDP Computer Systems	72
243	Tektronix Graphic System	Tektronix Inc.	12 & 13
	MASS STORAGE HARDWARE		
149	9 Track Tape System	A.K. Systems	198
111	9 Track Tape System	Catamount Corp.	196
133	Nine Track Tape	Flagstaff Engineering	142
108	"LEO"	Innovative Data Tech.	200
178	Speedstor	Maxtor	163
185	Nine Track Micro	Overland Data, Inc.	16
197	Batram	Santa Clara Systems	58
155	Multifunction Storage	Telebyte Technology Inc.	186
164	Back Up Systems	3M	46 & 47
	PRINTERS-PLOTTERS		
234	Laser Beam Printer	Canon USA Inc.	150 & 151
	INPUT SOFTWARE & HARDWARE		
118	The Transterm 5 Terminal	Computerwise, Inc.	196
	MODEMS		
213	The Courier Family	US Robotics	183
	DATA ACQUISITION		
209	Adalab-PC	Interactive Microware	198
	MONITORS		
237	Perpherals	Mitsubishi Electronics	56
156	MultiSync Monitor	NEC Home Electronics	26 & 27
202	Sigma VGA	Sigma Designs Inc.	101
	MICRO-MINI MAINFRAME COMMUNICATIONS		
248	5250—Communications	AST Research	146 & 147
216	Tempus-Share	Micro Tempus Inc.	159
169	Relay 3270	VM Personal Computer	119
246	Datagate/LAN-3270	Wall Data Inc.	153
	LOCAL AREA NETWORKS		
165	3-N-1	Attachmate Corporation	161
112	Lan Report #7	Novell	117
196	LAN Link	Software Link	50
	OTHER COMMUNICATION HARDWARE		
110	Digiboard COM/XI	Digiboard Inc.	182
123	LAN Gateway	Integrated Network System	157
177	Stargate OC8000	Stargate Technologies	144
246	LAN 3270	Wall Data	153
	COMMUNICATION SOFTWARE		
167	Crosstalk	Crosstalk Comm.	Back Cover
228	Carbon Copy	Meridien Technology	52
	SCIENTIFIC/ENGINEERING SOFTWARE		
245	ASYST	Asyst Software Technology	70
	APPLICATION SOFTWARE		
*	Harvard Project Manager	Software Publishing	76
	LANGUAGES		
136	Prolog Compiler	Arity Corporation	185
254	Pascal, Basic, Prolog	Borland Intl.	Front Gatefold Cover
131	C Products	Ecosoft Inc.	174
160	Lattice Services	Lattice, Inc.	165
229	Modula 2	Logitech Inc.	187
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150	MASM	Microsoft Corporation	39
145	Language Library	Microsoft Press	120 & 121
130	Brief	Solution Systems	14
207	True Basic	True BASIC Inc.	164

RS#	PRODUCT	ADVERTISER	PAGE
	PROGRAMMER'S TOOLS		
*	db/LIB	A.J.S. Publishing	115
105	PCAT ADA Compiler	Alsys, Inc.	88 & 89
214	ICD286	Answer Software	132
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119	R-Tree/C-Tree	FairCom	197
109	PC/Forms Screen Mgmt.	Golden Software	114
146	The Weiner Shell	Gryphon Microproducts	200
113	Flowchart	HavenTree Software	191
140	INRAC	John D. Owens Assoc.	192
125	Epsilon	Lugaru Software	138
148	C-Tree Query	Machine Ind. Software	140
259	386 Compiler	MetaWare	190
120	C Cross Compiler	MicroTec Research	116
191	Screenio	Norcom	202
186	C-Scape	Oakland Group	199
222	Recall, Sort & Scroll	Opt-Tech Data Processing	4
233	Programmers Tools	PC Brand	63–65
215	Periscope	Periscope Company	5
183	The Norton Editor	Peter Norton Computing	176
192	The Norton Editor	Peter Norton Utilities	42 & 43
190	PVCS	Polytron Corp.	133
252	Dis N Data	Pro-Am Software	144
198	The Seidl Make Utility	Seidl Computer Engrg.	154
201	B-Trieve	Soft Craft	2
142	Demo Program	Software Garden	156
171	High Screen XL	Softway Inc.	198
244	Stony Brook Modula 2	Stony Brook Software	170
152	"Keep Out" Slate System	Symmetry Group	162
115	Windows for Data	Vermont Creative	21
132	UI Programmer	Wallsoft Systems Inc.	172
154	XO-Shell	Wyte Corp.	178
	SOFTWARE UTILITIES		
232	PC Tools	Central Point Software	20
103	ellie	Elf Software	198
139	Bookmark	Intellisoft Intl.	194
191	Screenio	Norcom	202
168	Radix Screen Management	Radix Systems Inc.	193
	EXPERT SYSTEMS/AI SOFTWARE		
*	PC Scheme	Texas Instruments	84
	GRAPHICS SOFTWARE		
107	Graph C 4.0 and VTEK 4.0	Scientific Endeavors	200
	DATA MANAGEMENT SOFTWARE		
153	Magic PC	Aker Corporation	103
231	DBase III Plus	Ashton Tate	28 & 29
124	Revelation	Cosmos, Inc.	175
211	MDBS III	Micro Data Base Systems	111
224	Clipper	Nantucket Corp.	109
*	Professional Crack	Oracle Corp.	11
*	DB Vista/DB Query	Raima Corp.	86
*	ZIM	Zanthe	33–36
	OPERATING SYSTEMS		
141	Microport UNIX	Microport	135
174	MKS Tool Kit, AWK	Mortice Kern Systems, Inc.	195
181	QNX	Quantum Software Systems	78
137	DESKview	Quarterdeck Office Systems	80
	HARDWARE DIAGNOSTIC TOOLS		
253	PC-Technician and Windsor	Windsor Technologies	127
	PUBLICATIONS		
128	Improve your Memory	Addison Wesley Pub.	181
	OTHER SERVICES		
176	VAR/VAD	Tandy/Radio Shack	145
	SECURITY DEVICES		
157	Software Sentinel	Rainbow Technologies	184
189	The Block	Software Security	82
	MAIL ORDER		
147	Mail Order	Byte Connection, Inc.	210
117	Mail Order	CDA World of Computers	208
*	Mail Order	MicroWay	211
247	Mail Order	Precision Data Products	208
175	Mail Order	Programmer's Connection	23–25
173	Mail Order	Programmer's Paradise	209
162	Mail Order	Programmer's Shop	44
151	Mail Order	Programmer's Shop	89
240	Mail Order	Scantel Systems Ltd.	208
*	UNLock	TranSec Systems Inc.	210

INDEX TO ADVERTISERS

READER SERVICE NUMBER	ADVERTISER	PAGE
128	Addison Wesley	181
116	Advanced Logic	Back Gatefold Cover
*	AJS Publishing	115
153	Aker Corporation	103
149	AK Systems	198
105	Alsys	88 & 89
214	Answer Software	132
136	Arity Corporation	185
231	Ashton-Tate	28 & 29
248	AST Research	146 & 147
199	AST Research	96
245	ASYST Software	70
206	ATI Technologies	143
203	Atron	8
249	Atron	18
165	Attachmate Corporation	161
102	Blaise Computing	19
254	Borland Intl.	Front Gatefold Cover
147	Byte Connection, Inc.	210
234	Canon	150 & 151
111	Catamount Corporation	196
117	CDA World of Computers	208
232	Central Point	20
118	Computerwise, Inc.	196
101	Compuview	137
124	Cosmos	175
*	Creative Programming Cons	177
144	Crescent Software	158
167	Crosstalk Comm.	Back Cover
114	Cyber Tech	179
110	Digiboard Inc.	182
220	Digital Research	98
221	Digital Research	6 & 7
131	Ecosoft Inc.	174
103	Elf Software	198
119	FairCom	197
133	Flagstaff Engineering	142
109	Golden Software	114
146	Gryphon Microproducts Inc.	200
113	HavenTree Software	191
179	HiTech Materials	192
210	I-BUS Systems	136
122	IDEAssociates	155
108	Innovative Data Technology	200
123	Integrated Networking	157
187	Intel Corporation	166 & 167
139	Intellisoft	194
209	Interactive Microware	198
140	John D. Owens	192
242	Kontron	41
160	Lattice, Inc.	165
229	Logitech	187
125	Lugaru Software	138
148	Machine Ind. Software	140
161	Matrox	74
178	Maxtor	163
228	Meridian Technology	52
259	MetaWare	190
211	Micro Data Base Systems	111
141	MicroPort	135
*	Microsoft Corporation	17
150	Microsoft Corporation	39
145	Microsoft Press	120 & 121
180	Micro Sync Inc.	160
120	MicroTec Research	116
216	Micro Tempus	159
*	MicroWay	211
237	Mitsubishi	56
174	Mortice Kern Systems Inc.	195
224	Nantucket Corporation	109
156	NEC Home Electronics	26 & 27
191	Norcom	202
112	Novell	117
186	Oakland Group	199
222	Opt-Tech Data Processing	4
*	Oracle Corp.	11
185	Overland Data, Inc.	16
233	PC Brand	63–65
215	Periscope Company	5
227	Personal Comp. Graphics	22
223	Personal Comp. Support	94
192	Peter Norton Computing	42 & 43
183	Peter Norton Computing	176
190	Polytron	133
247	Precision Data	208
252	Pro/Am Software	144
175	Programmer's Connection	23–25
173	Programmer's Paradise	209
162	Programmer's Shop	44
151	Programmer's Shop	89
193	QDP Computer	72
181	Quantum Software	78
137	Quarterdeck Office Systems	80
168	Radix Systems	193
*	Raima Corp.	86
157	Rainbow Technologies, Inc.	184
197	Santa Clara	58
240	Scantel Systems Ltd.	208
107	Scientific Endeavors Corp.	200
198	Seidl Comp. Engrg.	154
202	Sigma Designs	101
201	SoftCraft	2
142	Software Garden	156
196	Software Link	50
*	Software Publishing	76
189	Software Security	82
171	Softway Inc.	198
130	Solution Systems	14
177	Stargate Technologies	144
244	Stoneybrook Software	170
152	Symmetry Group	162
176	Tandy Corp.	145
243	Tektronix	12 & 13
155	Telebyte	186
*	Texas Instruments	84
164	3 M	46 & 47
*	TranSec Systems Inc.	210
207	True BASIC, Inc.	164
213	U.S. Robotics	183
115	Vermont Creative	21
169	VM Personal Comp.	119
246	Wall Data	153
132	Wallsoft Systems Inc.	172
253	Windsor Technologies	127
154	Wyte Corp.	178
*	Zanthe	33–36

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102	117	132	147	162	177	192	207	222	237	252	267	282	297	312	327	342	357	372	387
103	118	133	148	163	178	193	208	223	238	253	268	283	298	313	328	343	358	373	388
104	119	134	149	164	179	194	209	224	239	254	269	284	299	314	329	344	359	374	389
105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	360	375	390
106	121	136	151	166	181	196	211	226	241	256	271	286	301	316	331	346	361	376	391
107	122	137	152	167	182	197	212	227	242	257	272	287	302	317	332	347	362	377	392
108	123	138	153	168	183	198	213	228	243	258	273	288	303	318	333	348	363	378	393
109	124	139	154	169	184	199	214	229	244	259	274	289	304	319	334	349	364	379	394
110	125	140	155	170	185	200	215	230	245	260	275	290	305	320	335	350	365	380	395
111	126	141	156	171	186	201	216	231	246	261	276	291	306	321	336	351	366	381	396
112	127	142	157	172	187	202	217	232	247	262	277	292	307	322	337	352	367	382	397
113	128	143	158	173	188	203	218	233	248	263	278	293	308	323	338	353	368	383	398
114	129	144	159	174	189	204	219	234	249	264	279	294	309	324	339	354	369	384	399
115	130	145	160	175	190	205	220	235	250	265	280	295	310	325	340	355	370	385	400

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102	117	132	147	162	177	192	207	222	237	252	267	282	297	312	327	342	357	372	387
103	118	133	148	163	178	193	208	223	238	253	268	283	298	313	328	343	358	373	388
104	119	134	149	164	179	194	209	224	239	254	269	284	299	314	329	344	359	374	389
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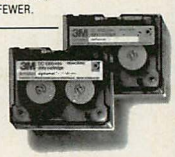
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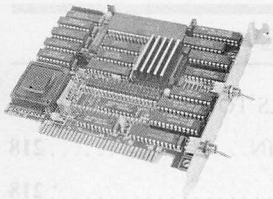
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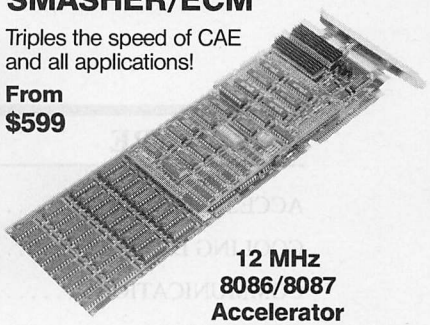
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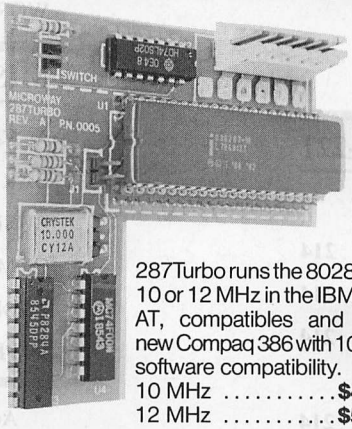
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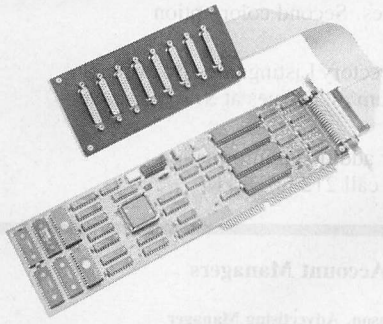
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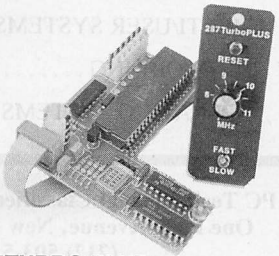
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PRODUCT CATEGORIES

HARDWARE 213

ACCESSORY CARDS 213
COOLING DEVICES .....
COMMUNICATIONS .....
COMPATIBLES 213
GENERAL .....
MASS STORAGE .....
PERIPHERALS 213
SECURITY DEVICES .....
USED EQUIPMENT .....

SOFTWARE 214-221

ARTIFICIAL INTELLIGENCE .....
BUSINESS 214
COMMUNICATIONS 214
DATA BASE MANAGEMENT 214
EDUCATIONAL .....
ENGINEERING 214
EXPERT SYSTEMS .....
FINANCIAL .....
GENERAL 214
GRAPHICS 214-215
LANGUAGES 215
MULTI/USER SYSTEMS .....
NETWORKING 215
OPERATING SYSTEMS 215-216

SOFTWARE *continued*

PROGRAMMERS TOOLS 216-217
PUBLIC DOMAIN 218
SCIENTIFIC 218
SECURITY DEVICES 218
STATISTICS 218
TERMINAL EMULATION 218
UTILITIES 219-221
WORD PROCESSING .....

MISCELLANEOUS 221

ACCESSORIES .....
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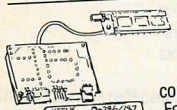
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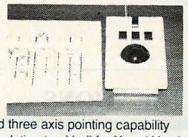
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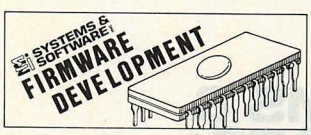
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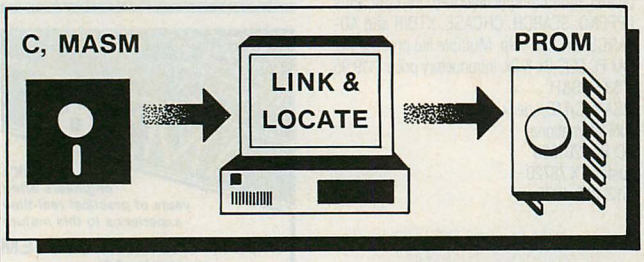
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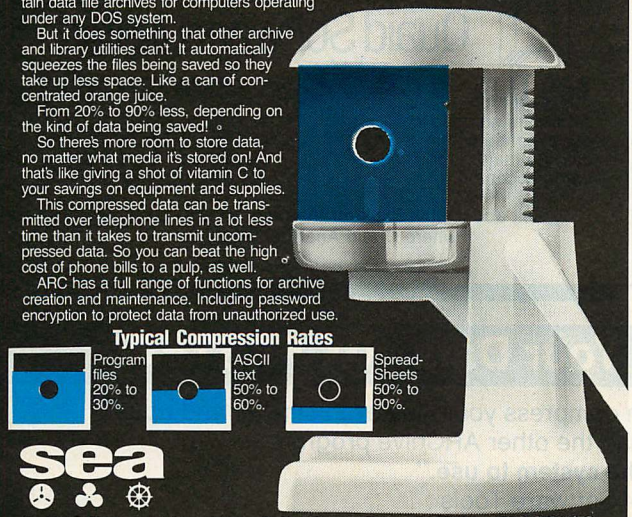
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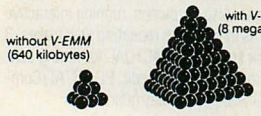
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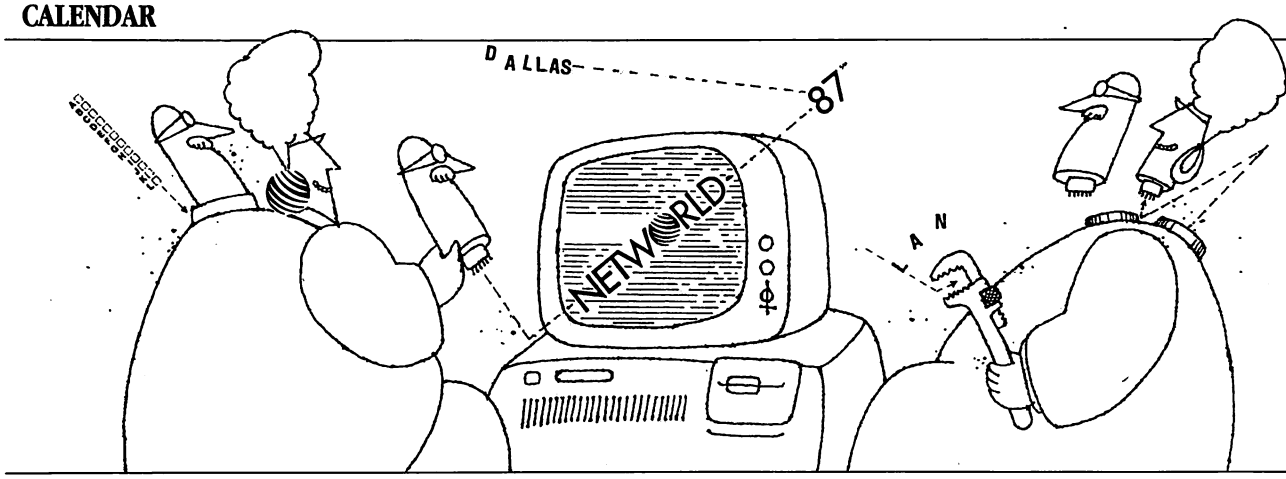


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October 3–6
GeoTech '87
Denver, CO (Computer-Oriented Geological Society) *Contact:* Stephen A. Krajewski, Geomath, Inc., 165 S. Union Blvd., Suite 410, Lakewood, CO 80228; 303/236-0772

October 4–8
OOPSLA '87
Kissimmee, FL (ACM SIGPLAN) *Contact:* Object Oriented Programming: Systems, Languages, and Applications Conference; ACM, 11 W. 42nd St., New York, NY 10036; 212/869-7440

October 5–6
Third Party Maintenance
San Francisco, CA (Frost & Sullivan) *Contact:* Frost & Sullivan, 106 Fulton St., New York, NY 10038; 212/233-1080

October 5–7
National Connectivity Symposium
Chicago, IL (Digital Consulting Associates, Inc.) *Contact:* Seminar Services Department, 6 Windsor Street, Andover, MA 01810; 617/470-3870

October 5–8
ASPLOS-II
Palo Alto, CA (ACM SIGPLAN) *Contact:* Architectural Support for Programming Languages and Operating Systems Conference, ACM, 11 W. 42nd St., New York, NY 10036; 212/869-7440

October 6–7
Data Security and Control: A Management Overview
New York, NY (New York University) *Contact:* NYU, School of Continuing Education, Seminar Center, 575 Madison Ave., New York, NY 10022; 212/580-5200

October 13–15
PC EXPO/Chicago
Chicago, IL (PC EXPO) *Contact:* Jim Mion, PC EXPO, 333 Sylvan Ave., Englewood Cliffs, NJ 07632; 800/922-0324; 201/569-8542

October 15–17
Northeast Computer Faire
Boston, MA (Interface Group) *Contact:* The Interface Group, Inc., 300 First Ave., Needham, MA 02194; 617/449-6600

October 19–23
Expert Systems in Government
Washington, DC (Mitre Corporation and IEEE-CS) *Contact:* IEEE-CS, 1730 Massachusetts Ave. NW, Washington, DC 20036; 202/371-0101

October 20–22
NetWorld '87
Dallas, TX (PC EXPO) *Contact:* Annie Zdinak, PC EXPO, 333 Sylvan Ave., Englewood Cliffs, NJ 07632; 800/526-3247; 201/569-6409

October 25–27
Print Quality Seminar
Bedford, MA (Datek) *Contact:* Frank Stefansson, Datek Information Services, Inc., P.O. Box 68, Newtonville, MA 02160; 617/893-9130

October 26–28
CEPS/Fall
Boston, MA (Cahners Exposition Group and InterConsult, Inc.) *Contact:* Corporate Electronic Publishing Systems Conference, InterConsult, Inc., 48 Brattle Street, Cambridge, MA 20138; 800/255-7798; 617/547-0332

October 27–29
UNIX EXPO
New York, NY (National Expositions Company) *Contact:* NEC, 49 W. 38th St., Suite 12A, New York, NY 10018; 212/391-9111

October 28–30
AI/East '87
Atlantic City, NJ (Tower Conference Management) *Contact:* TCM, 331 W. Wesley St., Wheaton, IL 60187; 312/668-8100

NOVEMBER

November 2–6
COMDEX/Fall
Las Vegas, NV (Interface Group) *Contact:* The Interface Group, Inc., 300 First Ave., Needham, MA 02194; 617/449-6600

November 2–4
DPMA Computer Conference
San Francisco, CA (Data Processing Management Association) *Contact:* DPMA, 505 Busse Hwy., Park Ridge, Il 60068-3191; 312/825-8124

November 9–11
Symposium on Operating System Principles
Austin, TX (ACM SIGOPS) *Contact:* Les Belady, MCC, 9430 Research Blvd., Echelon Bldg. 1, Suite 200, Austin, TX 78759; 512/834-3330

November 9–12
Mapping and Geographic Information Systems '87
San Diego, CA (National Computer Graphics Association) *Contact:* NCGA, 2722 Merrilee Dr., Suite 200, Fairfax, VA 22031; 800/225-6242; 703/698-9600

November 9–12
ICCAD-87
Santa Clara, CA (IEEE-CS) *Contact:* International Conference on CAD, IEEE-CS, 1730 Massachusetts Ave. NW, Washington, DC 20036-1903; 202/371-0101

November 11–13
Localnet '87
Los Angeles, CA (Online International) *Contact:* Online International, Inc., 989 Avenue of the Americas, New York, NY 10018; 212/279-8890

November 11–13
Optical Publishing and Storage
New York, NY (Learned Information) *Contact:* Learned Information, Inc., 143 Old Marlton Pike, Medford, NJ 08055; 609/654-6266

DECEMBER

December 1–3
Realtime Systems Symposium
San Jose, CA (IEEE-CS) *Contact:* Professor Kang G. Shin, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI 48109-1109; 313/763-0391

December 1–3
Optical Information Systems '87
New York, NY (Conference Management Corporation) *Contact:* Meckler Publishing, 11 Ferry Lane W, Westport, CT 06880; 203/226-6967

December 6–9
International Conference on Information Systems
Pittsburgh, PA (Society for Information Management) *Contact:* William D. King, Graduate School of Business, University of Pittsburgh, Pittsburgh, PA 15260; 412/648-1587

December 7–9
Performance 87
Brussels, Belgium (IFIP WG 7.3, Belgian National Science Foundation, and ACM SIGMETRICS) *Contact:* G. Latouche, Université du Bruxelles, Campus Pain CP212-bd du Triomphe, 1050 Bruxelles, Belgique

December 16–18
Microcomputer Graphics '87
New York, NY (Expoconsul International, Inc.) *Contact:* Expoconsul International, 3 Independence Way, Princeton, NJ 08540; 609/987-9400

JANUARY

January 5–8
Hawaii International Conference on System Sciences
Kailu-Kona, HI (IEEE-CS and ACM) *Contact:* Ralph H. Sprague, Jr., Decision Sciences Dept., University of Hawaii, 2404 Maile Way, E-303, Honolulu, HI 96822; 808/948-7430

January 13–15
Design Automation Workshop
Appache Junction, AZ (IEEE-CS) *Contact:* Walling Cyre, Control Data, HQM 173, P.O. Box 1249, Minneapolis, MN 55440; 612/853-2692

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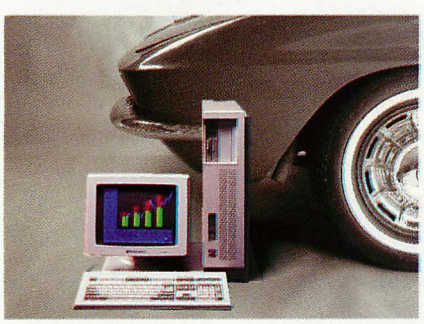
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- 101-key keyboard
- Shown with optional graphics adapter and monitor

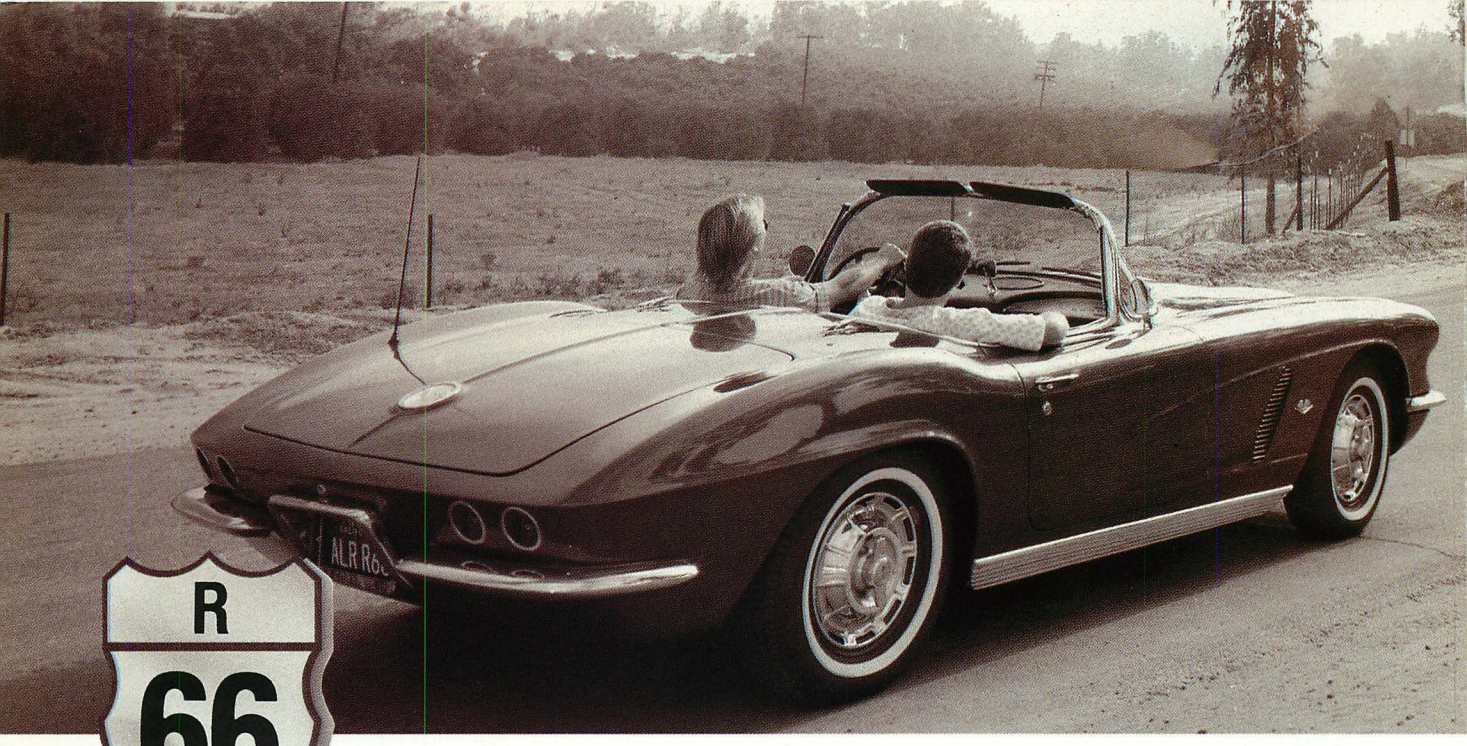
ALR 386/2 R66 $3490

- ALR-designed multilayer system board
- 80386-16 microprocessor, 20-MHz CPU speed optional
- Socketed for 80287 and 80387 support
- 1 MB 32-bit, 80-ns RAM, expandable to 2 MB on system board
- 66-MB, 28-ms hard disk drive
- 1 serial, 1 parallel port
- Phoenix BIOS
- 32-bit control software: Vdisk, disk caching, EMS and EEMS (optional)
- 1.2-MB, 5 1/4-inch floppy disk drive, 3 1/2-inch drives optional
- Eight expansion slots
- Floormount configuration
- 101-key keyboard
- Shown with optional graphics adapter and monitor

Advanced Logic Research, Inc.
10 Chrysler, Irvine, California, 92718
(714) 581-6770
FAX (714) 581-9240 Telex (510) 601-4525
Answer back Advanced Logic
From Asia and Europe, call Wearnes Technology,
Phone (65) 259-2521 Telex RS38113 WRNTEC

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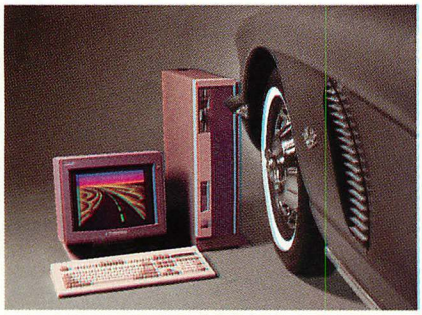


It Still Does.

Introducing R66™ Systems from Advanced Logic Research: 286 or 386 Fast, 66 MB Big.

Get Your Kicks on an R66.

Route 66, America's first transcontinental highway, inaugurated an exciting new way to travel—hurling down the road at wide-open speed, through wide-open space. Now, the spirit of Route 66 lives on with the introduction of Advanced Logic Research R66 systems.



Speed along with the Dart™ R66, a fast 10-MHz 286-based system, or really peel out with the ALR 386/2™ R66, a still faster 386-based system. And to make sure all that horsepower has room to run, both R66 systems include a speedy 66-MB, 28-ms hard disk.

Even better, R66 systems give you all this high performance computing power at about half the price of other comparable machines. For instance, compare the Dart R66 to the IBM PS/2™ Model 60 and AST Premium/286™ Model 140. They all share the same 10-MHz 80286 processor, which offers compatibility with IBM's OS/2, the newest generation of more powerful multitasking software. And they all feature the same first-rate design and first-class components. Yet the R66 still costs as little as half as much.

Break the Speed Limit.

In computing, like cross-country travel, speed is of the essence. And R66 systems deliver the power to take you wherever you want to go. Fast.

But to get outstanding PC performance, it takes more than just an 80286 or 80386 processor. Which is why every component in R66 systems is carefully designed for maximum overall system speed.

For example, R66 hard disks are rated at 28 ms average access time, 30% faster than the IBM Model 60. And R66 hard disks use 1:1 interleave for even faster disk operation, unlike AST's hard disk. R66 systems also transfer data from disk to memory at a scorching 390 KB/s, a full 50% faster than the other machines. The result? Fewer processing bottlenecks and faster system performance.

Soup Them Up.

If you're working on arithmetic-intensive graphics or database applications, the Dart R66 is socketed for 80287 coprocessor support, and the ALR 386/2 R66 is socketed for both 80287 and 80387 coprocessors.

And if you need the ultimate in flat-out speed, ask about the ALR 386/2 R66 equipped with 20-MHz processor speed.

	ALR Dart R66	ALR 386/2 R66	IBM PS/2 Model 60	AST Premium/286 Model 140
Price	$2295	$3490	$5295	$3495
Microprocessor	10-MHz 80286	16-MHz 80386	10-MHz 80286	10-MHz 80286
Hard disk	66 MB, 28 ms	66 MB, 28 ms	44 MB, 40 ms	44 MB, 28 ms
Data transfer rate	390 KB/s	390 KB/s	255 KB/s	255 KB/s
Interleaving	1:1	1:1	1:1	2:1
RAM	1 MB, expandable to 2 MB on system board	1 MB, expandable to 2 MB on system board	1 MB	1 MB
Coprocessor support	80287	80287 and 80387	80287	80287
Serial/parallel ports	2/2	1/1	1/1	1/1

Room to Roam.

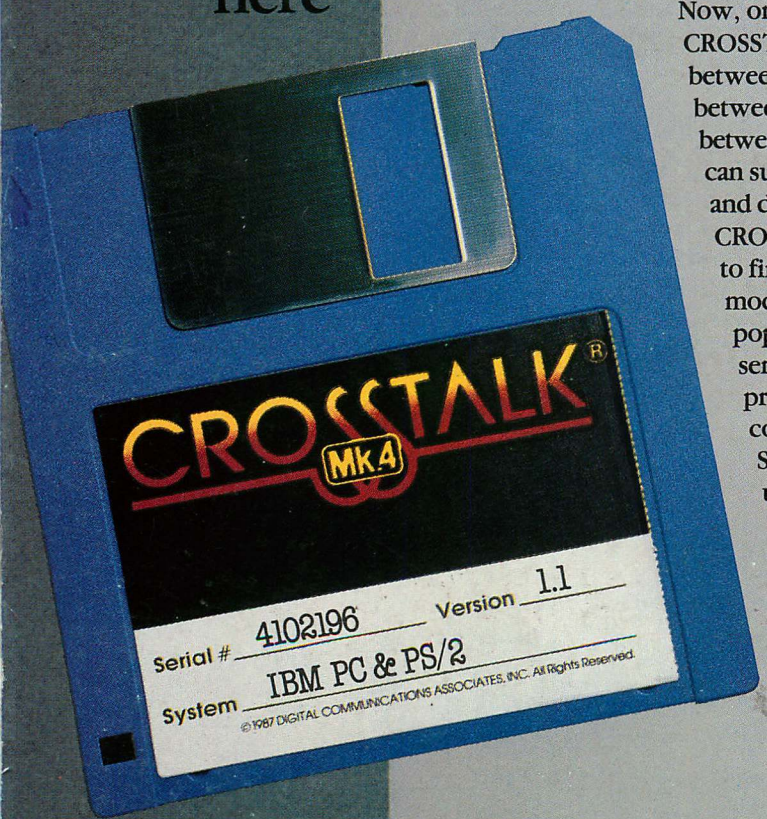
Advanced Logic Research R66 systems come with a 66-MB hard disk that's a full 50% larger than the ones you'll find on IBM and AST's machines. So you'll have half again as much disk space to spread out in.

IBM Spoken Here

and here

and here

and here



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